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CONTENTS

AMPHIBIANS OF INDIA: UPDATED SPECIES LIST WITH DISTRIBUTION RECORD

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ABSTRACT: A revised list of valid amphibian records from the political boundaries of the Republic of India is presented. A major taxonomic rearrangement, both at the generic and specific levels, is proposed. Excluding problematic or otherwise unverifiable species, the Indian amphibian fauna is at present known to comprise 197 species.

INTRODUCTION

The present list updates the one by Inger and Dutta (1986), which contained a list of 181 species then known to occur within the political boundaries of India. Information on original citations for each species, along with type localities, distribution and systematic notes on some species have been given in Dutta (in press).

Since Inger and Dutta's (1986) list, several papers have dealt with the Indian amphibian fauna, that describe new species and genera as well as report range extension (e.g., Chanda, 1986; 1990a; 1990b; Chanda and Ghosh, 1989; Dubois, 1984; 1985; 1986; 1987a; 1987b; Khan and Tasnim, 1989; Khare and Kiyasetuo, 1986; Kiyasetuo and Khare, 1986; 1987; Laurent, 1986; Mehta and Rao, 1987; Pillai, 1986; Sarkar and Sanyal, 1985; Tilak and Roy, 1985). Das (1990) updated species known during his time that were missing from the list by Inger and Dutta, as did Chanda and Ghosh (1988: but see below). The present paper thus contains several inclusions and deletions from the Indian amphibian faunal list, as well as significant relocations of previously recorded species. Information contained in two papers that were overlooked (Cherchi, 1954; Whitaker, 1978) have been incorporated in this paper.

Several recent publications (Daniel and Sekar, 1989; Kanamadi and Hiremath, 1989; Pillai, 1986; Sahi and Duda, 1985, 1986; Sarkar and Sanyal, 1985 and Uttangi, 1989) provide information about the range extension of many species. Hence, the distribution record of some of the species comprises specific localities within a state. As some of the species are found beyond Indian limits, the names of those countries have been incorporated into the present work.

The update by Chanda and Ghosh (1988) listed 13 species which these authors claimed were not incorporated in the 1986 paper, contains serious mistakes and therefore warrant a short review here.

1. *Megophrys kempii* (Annandale, 1912) has been considered by Gorham (1974) as a junior synonym of *M. boettgeri*. However, Frost (1985), without any comment, considered *M. kempii* as a distinct species because of lack of discussion by Gorham (1974). I have followed Gorham (1974) in considering *M. kempii* a junior synonym of *M. boettgeri*.

2. *Bufo sulphureus* Grandison and Daniel, 1964, is a junior synonym of *B. koynayensis* Soman, 1963 (Dutta, in press; Frost, 1985).

3. *Nyctibatrachus pygmaeus* (Günther, 1875) is a junior synonym of *N. deccanensis* Dubois, 1984 (replacement name for *Rana pygmaea* Günther, 1876 = *N. pygmaeus*, which is a junior primary homonym of *R. pygmaea* Spix, 1824), according to Dubois (1984).

4. *Nannobatrachus annamallaiensis* Myers, 1942, is a junior synonym of *N. beddomii* Boulenger, 1892 (Inger *et al.*, 1984; Dutta, in press).

5. *Micrixalus herrei* Myers, 1942, is a junior synonym of *M. fuscus* (Inger *et al.*, 1984; Dutta, in press).

6. *Rana bhagmandlensis* Rao, 1922, is a junior synonym of *R. aurantiaca* (Dutta, 1990).

7. *Rana erythraea* (Schlegel, 1837) from the Indian mainland *R. taipehensis* (Romer, 1951; Dutta, in press).

8 and 9. *Rana kuhlii* (= *Limnonectes kuhlii*) and *R. nigrovittata*, listed in Dutta (in press), have been omitted in error in Inger and Dutta's (1986) publication.

10. *Rana senchalensis* has been described by Chanda in 1986, the same year Inger and Dutta's paper was published.

11. *Philautus argus* (Annandale, 1912) is a junior synonym of *Amolops afghanus* (Boulenger, 1920; Bourret, 1942).

12 and 13. The replacement names for *Philautus longicrus* and *P. montanus* are *P. cmri* and *P. hassanensis* (Dutta, 1985), respectively.

Excluding the above species, two more species have been reported to occur within Indian limits (Das, 1967; Sahi and Duda, 1985; 1986; Sarkar and Sanyal, 1985). Sarkar and Sanyal (1985) tentatively assigned a mutilated specimen of *Bufo* from Arunachal Pradesh to *B. macrotis*. Das (1967) reported the occurrence of *Hynobius chinensis* (Chinese species) and *Pleurodeles verrucosus* from Kashmir. However, subsequent to Das (1967), these species have not been collected from Jammu and Kashmir and the specimens of either of the species from the area are not represented in any major museum collection.

A report by Das (1990) lists eight anurans (including *B. macrotis*) found approaching Indian limits and surveys are required to confirm their occurrence in the country.

The present work includes 197 species of amphibians now known to occur in India and a major taxonomic rearrangement (both at the generic and species levels) has been presented. I am solely responsible for errors related to such changes, and solicit comments from colleagues.

SPECIES LIST

CAUDATA (SALAMANDERS)

FAMILY: SALAMANDRIDAE

GENUS: *PLEURODELES* MICHANELLES, 1830

Pleurodeles verrucosus (Anderson, 1871):
Distribution: India---Arunachal Pradesh, West Bengal, Sikkim, Manipur and Meghalaya; outside India--- Myanmar, Bhutan, Thailand, Vietnam, Nepal and China.

GYMNOPHIONA (CAECILIANS)

FAMILY: ICHTHYOPHIIDAE

GENUS: *ICHTHYOPHIS* FITZINGER, 1826

Ichthyophis beddomei Peters, 1879:
Distribution: Kerala, Tamil Nadu, Karnataka, Sikkim and West Bengal.

Ichthyophis bombayensis Taylor, 1960:
Distribution: Maharashtra and Gujarat.

Ichthyophis longicephalus Pillai, 1986:
Distribution: Kerala.

Ichthyophis malabarensis Taylor, 1960:
Distribution: Kerala.

Ichthyophis peninsularis Taylor, 1960:
Distribution: Kerala and Tamil Nadu.

Ichthyophis sikkimensis Taylor, 1960:
Distribution: Sikkim and West Bengal.

Ichthyophis subterrestris Taylor, 1960:
Distribution: Maharashtra, Tamil Nadu and Kerala.

Ichthyophis tricolor Annandale, 1909:
Distribution: Kerala.

FAMILY: URAEOTYPHLIDAE

GENUS: *URAEOTYPHLUS* PETERS, 1879

Uraeotyphlus malabaricus (Beddome, 1870):
Distribution: Kerala and Tamil Nadu.

Uraeotyphlus menoni Annandale, 1913:
Distribution: Kerala.

Uraeotyphlus narayani Seshachar, 1939:
Distribution: Kerala.

Uraeotyphlus oxyurus (Duméril and Bibron, 1841):
Distribution: Tamil Nadu and Kerala.

FAMILY: CAECILIIDAE

GENUS: *GEGENEOPHIS* PETERS, 1879

Gegeneophis carnosus (Beddome, 1870):
Distribution: Kerala.

Gegeneophis fulleri (Alcock, 1904):
Distribution: Assam.

Gegeneophis ramaswamii Taylor, 1964:
Distribution: Kerala.

GENUS: *INDOTYPHLUS* TAYLOR, 1960

Indotyphlus battersbyi Taylor, 1960:
Distribution: Maharashtra.

ANURA (FROGS AND TOADS)

FAMILY: PELOBATIDAE

GENUS: *MEGOPHRYS* KUHL AND VAN HASSELT, 1822

Megophrys boettgeri (Boulenger, 1899):
Distribution: India---Assam and Arunachal Pradesh; outside India---China and Hong Kong.

Megophrys lateralis (Anderson, 1871):
Distribution: India---Assam; outside India---Bangladesh, Myanmar, Vietnam and China.

Megophrys parva (Boulenger, 1893):
Distribution: India---West Bengal, Sikkim, Assam and Meghalaya; outside India---Nepal, Bangladesh, Myanmar, Thailand, the Malay peninsula, Java and Borneo.

Megophrys robusta (Boulenger, 1908):
Distribution: West Bengal.

GENUS: *SCUTIGER* THEOBALD, 1868

Scutiger nyingchiensis Fei, 1977:
Distribution: India---Kashmir and Ladakh; outside India---Nepal.

Scutiger occidentalis Dubois, 1978:
Distribution: Jammu and Kashmir.

Scutiger sikimmensis (Blyth, 1854):
Distribution: India---Sikkim and West Bengal; outside India---Nepal, Myanmar and China.

FAMILY: BUFONIDAE

GENUS: *ANSONIA* STOLICZKA, 1870

Ansonia ornata Günther, 1875:
Distribution: Karnataka.

Ansonia rubigina Pillai and Pattabiraman, 1981:
Distribution: Kerala.

GENUS: *BUFO* LAURENTI, 1868

Bufo abatus Ahl, 1925:
Distribution: West Bengal.

Bufo beddomii Günther, 1875:
Distribution: Kerala.

Bufo brevirostris Rao, 1937:
Distribution: Karnataka.

Bufo camortensis Mansukhani and Sarkar, 1980:
Distribution: Andaman Island.

Bufo fergusonii Boulenger, 1892:
Distribution: India---Kerala, Tamil Nadu, Karnataka, Andhra Pradesh and Orissa; outside India---Sri Lanka.

Bufo himalayanus Günther, 1864:
Distribution: India---Himalayas: no specific locality, Sikkim, Meghalaya, Arunachal Pradesh and West Bengal; outside India---Nepal.

Bufo hololius Günther, 1875:
Distribution: Kerala.

Bufo koynayensis Soman, 1963:
Distribution: Maharashtra.

Bufo latastii Boulenger, 1882:
Distribution: India--- Ladakh; outside India---Pakistan and Nepal.

Bufo melanostictus Schneider, 1799:
Distribution: India---Throughout; outside India---Hong Kong, China, Pakistan, Sri Lanka, Bangladesh, Bhutan, Thailand, Myanmar, the Malay peninsula and the Philippines.

Bufo microtympanum Boulenger, 1882:
Distribution: India---Kerala; outside India---Sri Lanka.

Bufo parietalis Boulenger, 1882:
Distribution: Kerala.

Bufo silentvalleyensis Pillai, 1981:
Distribution: Kerala.

Bufo stomaticus Lutken, 1862:
Distribution: India---Kerala, Tamil Nadu, Andhra Pradesh, Karnataka Maharashtra, Orissa, West Bengal, Bihar, Uttar Pradesh, Punjab, Rajasthan, Gujarat, Jammu and Kashmir. Eastern Himalayas; no specific locality; outside India---Sri Lanka (introduced), Nepal, Bangladesh, Myanmar, Pakistan, eastern Iran, southern Afghanistan and the Arabian peninsula.

Bufo stuarti Smith, 1929:
Distribution: India---Assam; outside India---Myanmar.

GENUS: *BUFOIDES* PILLAI AND YAZDANI, 1973

Bufoides meghalayana (Yazdani and Chanda, 1971):
Distribution: Meghalaya.

GENUS: *PEDOSTIBES* GUNTHER, 1875

Pedostibes kempi (Boulenger, 1919):
Distribution: Meghalaya.

Pedostibes tuberculosus Günther, 1875:
Distribution: Kerala.

FAMILY: HYLIDAE

GENUS: *HYLA* LAURENTI, 1768

Hyla annectans Jerdon, 1870:
Distribution: India---Meghalaya and Assam; outside India---Myanmar, China, Thailand and Vietnam.

FAMILY: MICROHYLIDAE

GENUS: *KALOULA* GRAY, 1831

Kaloula baleata ghoshi Cherchi, 1954:
Distribution: Andaman Islands.

Kaloula pulchra Gray, 1831:
Distribution: India---West Bengal, Bihar, Madhya Pradesh, Orissa Tamil Nadu, Assam and Karnataka; outside India---Nepal, Sri Lanka, China, Hong Kong, Myanmar, Thailand, the Malay peninsula, Sumatra, Borneo, Sulawesi, and Flores, Singapore (introduced).

GENUS: *MELANOBATRACHUS* BEDDOME, 1878

Melanobatrachus indicus Beddome, 1878:
Distribution: Tamil Nadu and Kerala.

GENUS: *MICROHYLA* TSCHUDI, 1838

Microhyla berdmorei (Blyth, 1855):
Distribution: India---Meghalaya; outside India---Myanmar, Thailand, Cambodia, the Malay peninsula and Sumatra.

Microhyla chakrapani Pillai, 1977:
Distribution: North Andamans.

Microhyla heymonsi Vogt, 1911:
Distribution: India---Great Nicobar Island; outside India---Thailand, Taiwan, China, the Malay peninsula and Sumatra.

Microhyla ornata (Duméril and Bibron, 1841):
Distribution: India---Throughout; outside India---Pakistan, Nepal, Sri Lanka, Bangladesh, Myanmar, Thailand, China, Japan, Taiwan and the Malay peninsula.

Microhyla rubra Jerdon, 1854:
Distribution: India---Assam, West Bengal, Tamil Nadu, Karnataka Kerala; outside India---Sri Lanka.

GENUS: *MICRYLETTA* DUBOIS, 1987

Micryletta inornata (Boulenger, 1890):
Distribution: India---Andaman Islands; outside India---Thailand, Myanmar, China, the Malay peninsula and Sumatra.

GENUS: *RAMANELLA* RAO AND RAMANNA, 1925

Ramanella anamalaiensis Rao, 1937:
Distribution: Tamil Nadu and Kerala.

Ramanella minor Rao, 1937:
Distribution: Karnataka.

Ramanella montana (Jerdon, 1854):
Distribution: Kerala, Tamil Nadu, Maharashtra and Gujarat.

Ramanella mormorata Rao, 1937:
Distribution: Karnataka.

Ramanella triangularis Günther, 1875:
Distribution: Tamil Nadu, Kerala and Karnataka.

Ramanella variegata (Stoliczka, 1872):
Distribution: India---Madhya Pradesh, Orissa, West Bengal, Tamil Nadu, Karnataka and Kerala; outside India---Sri Lanka.

GENUS: *UPERODON* DUMÉRIL AND BIBRON, 1841:

Uperodon globulosus (Günther, 1854):
Distribution: West Bengal, Assam, Orissa, Madhya Pradesh, Maharashtra, Karnataka, Bihar and Gujarat.

Uperodon systoma (Schneider, 1799):
Distribution: India---Himachal Pradesh, Rajasthan, West Bengal, Orissa Uttar Pradesh, Tamil Nadu, Kerala and Karnataka; outside India---Sri Lanka and Nepal.

FAMILY: RANIDAE

GENUS: *AMOLOPS* COPE, 1865

Amolops afghanus (Günther, 1858):
Distribution: India---Sikkim, West Bengal, Meghalaya, and Arunachal Pradesh; outside India---China, Myanmar and Nepal.

Amolops formosus (Günther, 1875):
Distribution: India---West Bengal, Himachal Pradesh, Meghalaya and Sikkim; outside India---Nepal.

Amolops monticola (Anderson, 1871):
Distribution: India---West Bengal; outside India---China (Tibet).

GENUS: *INDIRANA* LAURENT, 1986:

Indirana beddomii (Günther, 1876):
Distribution: Kerala and Maharashtra.

Indirana brachytarsus (Günther, 1876):
Distribution: Kerala and Tamil Nadu.

Indirana diplostictus (Günther, 1876):
Distribution: Kerala and Tamil Nadu.

Indirana gundia (Dubois, 1985):
Distribution: Karnataka.

Indirana leithii (Boulenger, 1888):
Distribution: Maharashtra, Gujarat, Kerala and Madhya Pradesh.

Indirana leptodactylus (Boulenger, 1882):
Distribution: Kerala.

Indirana phrynoderma (Boulenger, 1882):
Distribution: Kerala.

Indirana semipalmatus (Boulenger, 1882):
Distribution: Kerala.

Indirana tenuilingua (Rao, 1937):
Distribution: Karnataka.

GENUS: *LIMNONECTES* FITZINGER, 1843

Limnonectes andamanensis (Stoliczka, 1870):
Distribution: South Andaman Island.

Limnonectes brevipalmata (Peters, 1871):
Distribution: Kerala and Tamil Nadu.

Limnonectes cancrivorus (Gravenhorst, 1829):
Distribution: India---Madhya Pradesh; outside India---the Philippines, the Malay peninsula, Sumatra, Java, Borneo and the Lesser Sundas.

Limnonectes crassus (Jerdon, 1853):
Distribution: India---Andhra Pradesh, Bihar, Karnataka, Uttar Pradesh, West Bengal, Orissa, Tamil Nadu (Madurai District) and Kerala; outside India---Sri Lanka and Nepal.

Limnonectes doriae (Boulenger, 1887):
Distribution: India---Andaman Islands; outside India---Myanmar, Thailand and the Malay peninsula.

Limnonectes hascheana (Stoliczka, 1870):
Distribution: India--- Andaman Islands; outside India---Myanmar, Thailand, Vietnam, the Malay peninsula and Java.

Limnonectes keralensis (Dubois, 1980):
Distribution: Kerala.

Limnonectes khasiensis (Anderson, 1871):
Distribution: Meghalaya.

Limnoectes kuhlii (Tschudi, 1838):
Distribution: India---Assam and Meghalaya; outside India---China, Taiwan, the Malay peninsula, Java, Sumatra and Borneo.

Limnonectes laticeps (Boulenger, 1882):
Distribution: India---Assam, West Bengal, Meghalaya; outside India---Bangladesh, Myanmar, Thailand, the Malay peninsula, Jawa, Sumatra and Borneo.

Limnonectes limnocharis (Gravenhorst, 1829):
Distribution: India---Throughout; outside India---Pakistan, Sri Lanka, Nepal, Bhutan, Bangladesh, Myanmar, China, Japan, Taiwan, the Philippines, the Malay peninsula, Sumatra, Java and Borneo.

Limnonectes macrodon (Duméril and Bibron, 1841):
Distribution: India---Sikkim; outside India---Singapore, Myanmar and Java.

Limnonectes mawphlangensis (Pillai and Chanda, 1977):
Distribution: Meghalaya, West Bengal and Manipur.

Limnonectes murthii (Pillai, 1979):
Distribution: Kerala.

Limnonectes nilagirica (Jerdon, 1853):
Distribution: Kerala and Tamil Nadu.

Limnonectes sauriceps (Rao, 1937):
Distribution: Karnataka.

Limnonectes syhadrensis (Annandale, 1919):
Distribution: India---Maharashtra; outside India---Pakistan and Nepal.

Limnonectes tigerinus (Daudin, 1802):
Distribution: India---Throughout; outside India---Pakistan, Sri Lanka, Nepal, Bhutan, Bangladesh and Madagascar (introduced).

GENUS: *MICRIXALUS* BOULENGER, 1888

Micrixalus borealis Annandale, 1912:
Distribution: Arunachal Pradesh.

Micrixalus fuscus (Boulenger, 1882):
Distribution: Kerala, Tamil Nadu and Karnataka.

Micrixalus nudis Pillai, 1978:
Distribution: Kerala.

Micrixalus opisthorhodus (Günther, 1868):
Distribution: Kerala.

Micrixalus saxicola Jerdon, 1853:
Distribution: Kerala.

Micrixalus silvaticus (Boulenger, 1882):
Distribution: Kerala and Tamil Nadu.

Micrixalus thampii Pillai, 1981:
Distribution: Kerala.

GENUS: *NANNOBATRACHUS* BOULENGER, 1882

Nannobatrachus beddomii Boulenger, 1882:
Distribution: Kerala and Tamil Nadu.

Nannobatrachus kempholeyensis Rao, 1937:
Distribution: Karnataka.

GENUS: *NYCTIBATRACHUS* BOULENGER, 1882

Nyctibatrachus aliciae Inger, Shaffer, Koshy and Bakde, 1984:
Distribution: Kerala.

Nyctibatrachus humayuni Bhaduri and Kripalani, 1955:
Distribution: Maharashtra and Karnataka.

Nyctibatrachus major Boulenger, 1882:
Distribution: Kerala and Tamil Nadu.

Nyctibatrachus minor Inger, Shaffer, Koshy and Bakde, 1984:
Distribution: Kerala.

Nyctibatrachus sanctipalustris Rao, 1920:
Distribution: Karnataka.

Nyctibatrachus sylvaticus Rao, 1937:
Distribution: Karnataka.

GENUS: *OCCIDOZYGA* KUHL AND VAN HASSELT, 1822

Occidozyga cyanophlyctis Schneider, 1799:
Distribution: India---Throughout; outside India---Afghanistan, Pakistan, Nepal, Bhutan, Bangladesh, Myanmar and Sri Lanka.

Occidozyga ghoshi (Chanda, 1990):
Distribution: Manipur.

Occidozyga hexadactyla (Lesson, 1834):
Distribution: India---Kerala, Tamil Nadu, Maharashtra, Goa, Gujarat, Karnataka, Andhra Pradesh, Orissa (probably introduced), West Bengal and Rajasthan (?); outside India---Sri Lanka and Bangladesh.

Occidozyga lima (Gravenhorst, 1829):
Distribution: India---West Bengal; outside India---Myanmar, China, Thailand, the Malay peninsula and Java.

GENUS: *PTERORANA* KIYASETUO AND KHARE, 1986

Pterorana khare Kiyasetuo and Khare, 1986:
Distribution: Nagaland.

GENUS: *RANA* LINNAEUS, 1758

Rana albolineata (Dubois, 1985):
Distribution: Meghalaya.

Rana alticola Boulenger, 1882:
Distribution: India---Meghalaya and Sikkim; outside India---Bangladesh, Myanmar and Vietnam.

Rana annandalii Boulenger, 1920:
Distribution: India---West Bengal; outside India---Nepal.

Rana assamensis Sclater, 1892:
Distribution: India---West Bengal and Meghalaya; outside India---Nepal.

Rana aurantiaca Boulenger, 1904:
Distribution: India---Kerala and Karnataka; outside India---Sri Lanka.

Rana barmoachensis Khan and Tasmin, 1989:
Distribution: India--- Kashmir.

Rana blanfordii Boulenger, 1882:
Distribution: India---Meghalaya, Uttar Pradesh and West Bengal; outside India---Nepal.

Rana curtipes Jerdon, 1853:
Distribution: Kerala and Karnataka.

Rana danieli Pillai and Chanda, 1977:
Distribution: Meghalaya.

Rana garoensis Boulenger, 1920:
Distribution: Meghalaya.

Rana gerbillus Annandale, 1912:
Distribution: India---Meghalaya, Assam, West Bengal; outside India---China and Myanmar.

Rana intermedius Rao, 1937:
Distribution: Karnataka.

Rana leptoglossa (Cope, 1868):
Distribution: India---Assam and Meghalaya; outside India---Myanmar, Thailand and Vietnam.

Rana liebigii Günther, 1860:
Distribution: India---Uttar Pradesh, Sikkim, West Bengal, Himachal Pradesh and Jammu and Kashmir; outside India---Nepal and China.

Rana livida (Blyth, 1855):
Distribution: India---West Bengal, Assam, Sikkim, Meghalaya and Manipur; outside India---Myanmar, Vietnam, China, Thailand and the Malay peninsula.

Rana malabarica Tschudi, 1838:
Distribution: Maharashtra, Kerala, Gujarat, Goa and Madhya Pradesh.

Rana mawlyndipi Chanda, 1990:
Distribution: Meghalaya.

Rana minica Dubois, 1975:
Distribution: India---Uttar Pradesh and Himachal Pradesh; outside India---Nepal.

Rana nicobariensis (Stoliczka, 1870):
Distribution: India---Assam and Nicobar Islands; outside India---Myanmar, Thailand, the

Malay peninsula, Sumatra, Java, Borneo and the Philippines.

Rana nigrovittata (Blyth, 1855):
Distribution: India---Assam; outside India---Myanmar, Thailand and the Malay peninsula.

Rana senchalensis Chanda, 1986:
Distribution: West Bengal.

Rana sikimmensis Jerdon, 1870:
Distribution: India---West Bengal, Meghalaya and Sikkim; outside India---Nepal.

Rana sternosignata Murray, 1885:
Distribution: India---Jammu and Kashmir; outside India---Pakistan.

Rana taipehensis Van Denburgh, 1909:
Distribution: India---Assam, Uttar Pradesh, West Bengal and Orissa; outside India---Nepal, Taiwan, Hong Kong and Myanmar.

Rana temporalis (Günther, 1864):
Distribution: India---Kerala, Tamil Nadu, Karnataka and Maharashtra; outside India---Sri Lanka.

Rana tuberculata Tilak and Roy, 1985:
Distribution: Uttar Pradesh.

Rana vicina Stoliczka, 1872:
Distribution: India---Himachal Pradesh, Jammu and Kashmir, Punjab and Uttar Pradesh; outside India---Pakistan.

GENUS: *TOMOPTERNA* DUMÉRIL AND BIBRON, 1841:

Tomopterna breviceps (Schneider, 1799):
Distribution: India---Orissa, Andhra Pradesh, Bihar, Gujarat, Maharashtra, Kerala, Tamil Nadu, Karnataka and Rajasthan; outside India---Pakistan, Nepal, Myanmar and Sri Lanka.

Tomopterna dobsonii (Boulenger, 1882):
Distribution: Karnataka, Tamil Nadu and Andhra Pradesh.

Tomopterna leucorhynchus (Rao, 1937):
Distribution: Karnataka.

Tomopterna parambikulamana (Rao, 1937):
Distribution: Kerala.

Tomopterna rolandae (Dubois, 1983):
Distribution: India---Himachal Pradesh, Bihar, Orissa, Kerala, Uttar Pradesh, Madhya Pradesh, Andhra Pradesh, Tamil Nadu and West Bengal; outside India---Sri Lanka.

Tomopterna rufescens (Jerdon, 1854):
Distribution: Kerala and Maharashtra.

FAMILY: RHACOPHORIDAE

GENUS: *CHIRIXALUS* BOULENGER, 1893

Chirixalus doriae Boulenger, 1893:
Distribution: Arunachal Pradesh.

Chirixalus simus Annandale, 1915:
Distribution: Assam.

Chirixalus vittatus (Boulenger, 1887):
Distribution: India---Nagaland; outside India---Myanmar.

GENUS: *NYCTIXALUS* BOULENGER, 1882

Nyctixalus moloch (Annandale, 1912):
Distribution: India---Arunachal Pradesh and Assam; outside India---China (Tibet) and Myanmar.

GENUS: *PHILAUTUS* GISTEL, 1848

Philautus andersonii (Ahl, 1927):
Distribution: India---Assam and Meghalaya; outside India---Myanmar and China (Yunnan and Tibet).

Philautus annandalii (Boulenger, 1906):
Distribution: India---West Bengal, Meghalaya and Assam; outside India---Bhutan.

Philautus beddomii (Günther, 1875):
Distribution: Kerala.

Philautus bombayensis (Annandale, 1919):
Distribution: Maharashtra and Karnataka.

Philautus chalazodes (Günther, 1875):
Distribution: Kerala and Tamil Nadu.

Philautus charius Rao, 1937:
Distribution: Kerala and Karnataka.

Philautus cherrapunjiae Roonwal and Kripalani, 1961:
Distribution: Meghalaya and Arunachal Pradesh.

Pilautus crnri Dutta, 1985:
Distribution: Karnataka.

Philautus elegans Rao, 1937:
Distribution: Karnataka.

Philautus femoralis (Günther, 1864):
Distribution: India---Kerala; outside India---Sri Lanka.

Philautus flaviventris (Boulenger, 1882):
Distribution: Kerala.

Philautus garo (Boulenger, 1919):
Distribution: Meghalaya.

Philautus glandulosus (Jerdon, 1853):
Distribution: Maharashtra, Kerala and Tamil Nadu.

Philautus hassanensis Dutta, 1985:
Distribution: Karnataka.

Philautus kempiae (Boulenger, 1919):
Distribution: Meghalaya.

Philautus kottigeharensis Rao, 1937:
Distribution: Karnataka.

Philautus leucorhinus (Lichtenstein and Martens, 1856):
Distribution: India---Kerala and Karnataka; outside India---Sri Lanka.

Philautus melanensis Rao, 1937:
Distribution: Karnataka.

Philautus namdaphaensis Sarkar and Sanyal, 1985:
Distribution: Arunachal Pradesh.

Philautus narainensis Rao, 1937:
Distribution: Karnataka.

Philautus noblei (Ahl, 1927):
Distribution: Kerala.

Philautus pulcherrimus (Ahl, 1927):
Distribution: Kerala.

Philautus shillongensis Pillai and Chanda, 1973:
Distribution: Meghalaya.

Philautus shyamrupus Chanda and Ghosh, 1989:
Distribution: Arunachal Pradesh.

Philautus signatus (Boulenger, 1882):
Distribution: Kerala and Tamil Nadu.

Philautus swamianus Rao, 1937:
Distribution: Karnataka.

Philautus temporalis (Günther, 1864):
Distribution: India---Kerala: outside India---Sri Lanka.

Philautus travancoricus (Boulenger, 1891):
Distribution: Kerala.

Philautus tuberculatus (Anderson, 1878):
Distribution: India---Assam and Meghalaya; outside India---Myanmar.

Philautus variabilis (Günther, 1858):
Distribution: India---Andhra Pradesh, Tamil Nadu, Kerala; outside India---Sri Lanka.

GENUS: *POLYPEDATES* TSCHUDI, 1838

Polypedates cruciger Blyth, 1852:
Distribution: India---Tamil Nadu and Karnataka; outside India---Sri Lanka.

Polypedates leucomystax (Gravenhorst, 1829):
Distribution: India---Madhya Pradesh, West Bengal, Meghalaya, Manipur, Arunachal Pradesh, Gujarat, Assam and Sikkim; outside India---China, Nepal, Bangladesh, Taiwan, Singapore, the Philippines, the Malay peninsula, Java, Sumatra, Borneo, Thailand and Japan (Okinawa: introduced).

Polypedates maculatus (Gray, 1834):
Distribution: India---Throughout (except Haryana, Punjab and Rajasthan); outside India---Sri Lanka, Nepal and Bangladesh.

GENUS: *RHACOPHORUS* KUHL AND VAN HASSELT, 1822

Rhacophorus appendiculatus (Günther, 1859):
Distribution: India---Arunachal Pradesh; outside India---the Philippines, the Malay peninsula, Sumatra and Borneo.

Rhacophorus bipunctatus Ahl, 1927:
Distribution: India---Meghalaya and Arunachal Pradesh; outside India---Thailand.

Rhacophorus bisacculus Taylor, 1962:
Distribution: India---Nagaland; outside India---Thailand.

Rhacophorus calcadensis Ahl, 1927:
Distribution: Tamil Nadu.

Rhacophorus dubius Boulenger, 1882:
Distribution: West Bengal.

Rhacophorus jerdonii (Günther, 1875):
Distribution: West Bengal, Assam and Arunachal Pradesh.

Rhacophorus lateralis Boulenger, 1883:
Distribution: Kerala.

Rhacophorus malabaricus Jerdon, 1870:
Distribution: Kerala, Karnatak and Goa.

Rhacophorus maximus Günther, 1858:
Distribution: India---West Bengal, Assam, Arunachal Pradesh and Meghalaya; outside India---Nepal, China (Yunnan and Tibet).

Rhacophorus namdaphaensis Sarkar and Sanyal, 1985:
Distribution: Arunachal Pradesh.

Rhacophorus naso Annandale, 1912:
Distribution: Arunachal Pradesh.

Rhacophorus pleurostictus (Günther, 1864):
Distribution: Kerala and Tamil Nadu.

Rhacophorus taeniatus Boulenger, 1906:
Distribution: Bihar; outside India---Bangladesh.

Rhacophorus tuberculatus (Anderson, 1871):
Distribution: West Bengal and Assam.

GENUS: *THELODERMA* TSCHUDI, 1838

Theloderma asper (Boulenger, 1886):
Distribution: India---Arunachal Pradesh; outside India---Thailand, Myanmar, Vietnam and the Malay peninsula.

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AMPHIBIAN PARASITES OF KODIAKARAI AREA (POINT CALIMERE), TAMIL NADU, SOUTH INDIA

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ABSTRACT: A total of 295 amphibians, representing five species, collected from Kodiakarai were found infected by 10 species of helminths. The incidence of helminth infection varied among the various hosts. An ecological analysis of the incidence of these parasites is conducted. The affinity of the parasites to the various hosts indicates that a helminth may parasitize various hosts in its area of distribution.

INTRODUCTION

Amphibians form a major nutritional source for reptiles, birds and mammals, and also serve as intermediate, complementary or reservoir hosts for some of the helminths infecting domestic and wild animals (Prokopic and Krivanec, 1975). The presence of one parasite species in a host may affect the distribution and indirectly the fecundity of another or even affect the populations of other species directly (Cross, 1934; Chappel, 1969). In view of the lack of information on the distribution of the helminths of south Indian amphibians, the present study was conducted to partially fill the gaps in our knowledge of the south Indian amphibian parasites with the following objectives:

1. To examine the prevalence of infection of digenetic trematodes, cestodes and nematodes in amphibians, and 2. to understand the host-parasite relationship.

MATERIALS AND METHODS

Two hundred and ninety-five amphibians, consisting of 15 *Rana tigerina*, 119 *Rana cyanophlyctis*, 106 *Bufo melanostictus*, 42 *Microhyla ornata* and 13 *Polypedates maculatus* were collected in different localities in and around Kodiakarai (Point Calimere), 125 km away Mayiladuthurai, Tamil Nadu State, India. Collections were fortnightly. Frogs were brought to the laboratory, killed with chloroform and dissected to expose the body cavity. The helminths were fixed, dehydrated and stained with haematoxylin and mounted in DPX.

OBSERVATIONS

The results show that the percentage of infection is highest in *R. tigerina* (100), followed by *B. melanostictus* (99.1). Though the rate of infection in *R. tigerina* is the highest, we refrain from commenting on the implications due to the small sample size (n = 15). In *M. ornata*, *R. cyanophlyctis* and *P. maculatus*, the percent-

TABLE 1: Incidence of parasitization in each of the amphibian species examined. (figures in parentheses indicate the actual number of animals infected).

Host	Individuals examined	Percentage infected
Rana tigerina	15	100.0 (15)
Rana cyanophlyctis	119	75.6 (90)
Bufo melanostictus	106	99.1 (105)
Microhyla ornata	42	78.5 (33)
Polypedates maculatus	13	61.5 (8)

ages of incidence were 78.5, 75.6 and 61.5, respectively (Table 1).

The digenetic trematodes infected only *R. tigerina* and *R. cyanophlyctis* (73 and 57.9% respectively). *B. melanostictus*, *M. ornata* and *P. maculatus* were not infected with trematodes. Cestode infection was found only in *B. melanostictus*. Nematode infection was observed in all the five host species. The rate of nematode infection was highest (98.1%) in *B. melanostictus* (Table 2).

TABLE 2. Number of individuals of host species infected with digenetic trematodes, cestodes and nematodes.

Parasites	*Rana tigerina*		*Rana cynophlyctis*		*Bufo melanostictus*		*Microhyla ornata*		*Polypedates maculatus*	
	No.	%	No.	%	No.	%	No.	%	No.	%
Digenetic trematodes	11	73.3	69	57.9	-	-	-	-	-	-
Cestodes	-	-	-	-	9	8.4	-	-	-	-
Nematodes	12	80	42	35.2	104	98.1	34	78.5	5	38.5

AFFINITY OF HELMINTHS TO VARIOUS HOSTS

The cestode *N. dispar* with a percentage of infection 8.4 was found to occur only in *B. melanostictus*. The nematode *C. longicauda* was parasitic in all the five amphibian species. *C. ornata* and *O. filiforms* were found infecting all amphibians except *P. maculatus*. Of the trematode species, all the four occurred in the species of *Rana* (Table 1).

DISCUSSION

Prokopic and Krivanec (1975) suggested that the composition of the helminth fauna of amphibians depends on the respective host's habitat. The aquatic amphibians, *R. tigerina* and *R. cyanophlyctis* were found infected with digenetic trematodes, while the terrestrial forms, *B. melanostictus* and *Microhyla ornata* and the arboreal *P. maculatus* were not. Loos (1894), Bychowaky (1933), Dubinina (1950), Volna (1964), Kozak (1969) and Vojtkova (1972) also inferred that the hosts living in aquatic environments are infected mainly with trematodes, while those inhabiting the land are infected with nematodes. The observations made in the present study are concordant with the views of the earlier authors with regard to the prevalence of the single parasitic species either in a single host or a group of hosts.

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OBSERVATIONS ON THE TERRITORY-MARKING BEHAVIOUR OF THE GECKO *EUBLEPHARIS MACULARIUS*

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ABSTRACT: The territory-marking behaviour of the leopard gecko (*Eublepharis macularius*) consists of the deposition of a waxy secretion from its preanal glands and an intimidatory display which sometimes results in combat between two males. In two cases, marking behaviour was observed which appear similar to that reported in psammophine snakes.

INTRODUCTION

Eublepharis is the type genus of the gecko family Eublepharidae which has recently been reviewed by Grismer (1988). The best known species is *Eublepharis macularius* whose distributional range covers Pakistan and areas in western India. Breeding is common in captivity and animals have been used in numerous scientific studies on reptilian biology (cf. De Vosjoli, 1990). The lizard is quite common in arid areas, such as semi-deserts and dry scrub. Being nocturnal, it seeks shelter beneath rocks and stones by day and is thus rarely encountered in full daylight. Similar observations have been made by Brillet (1991) and Greenberg (1943), the western banded gecko *Coleonyx variegatus*. In both species, males are recognisable by the presence of preanal glands (Mertens, 1959). The waxy secretion of these glands is used in territory-marking.

The present paper deals with the territorial-marking behaviour of males of *Eublepharis macularius* studied under laboratory conditions, adding new information on marking behaviour.

MATERIAL AND METHODS

Eleven animals were kept in glass cages 60 x 60 x 60 cm with air slots on the lid and on one side covered with mesh. The front consisted of sliding doors. Ambient temperatures varied between 27° C during the day (0800 to 2000 hours) and 20° C at night (2000 to 0800 hours). Heat was supplied by a 60W bulb and two bottom heaters beneath stones producing a local maximum temperature of 32° C during the day. In winter, no heating was supplied, when temperatures were 23° C. by day and about 17° C by night. All observations were carried out during spring and summer (March to September). The ground substrate was composed of 4 mm mineral granulate. Each cage contained two caves made of stones. The floor inside the caves was covered with moist sand, that was sprayed daily with water to keep humidity high.

All animals were obtained from the same stock but belonged to different generations. No two lizards kept together came from the same clutch.

In terms of numbers of individuals and sexes in each cage, three combinations were tested: type A: one male and one female; type B: one male and two females; type C: two males and one female. Observations were carried out every day between 2000 to 2400 hours.

OBSERVATIONS

In cage type C, territorial behaviour was expressed frequently (Table 1). Usually the dominant male occupied a certain heating place which was defended. By means of preanal glands, an invisible border was maintained. The line did not surround the heating place, i.e., each lizard just marked a boundary in front of its contestant. This marking procedure was performed as a ritual starting a high walk up and down the border, the body raised high in the air and the tail waved in a cat-like

manner. The posterior part of the body was then lowered and a mark deposited on the ground. This behaviour continued as long as the other male was watching. As soon as the rival crossed the territory boundary, combat took place. Animals only fought in the dominant male's heating territory and combat stopped as soon as the intruder retreated. Observations suggest that it is the territory-holder who succeeds in the fights which was the case in all observations carried out (i.e., 23 fights). Interestingly, the males were often seen spending the nights together in the same shelters.

Although males in cage types A and B were occasionally seen licking their preanal glands, no action of "smearing" or "rubbing" have been observed.

The geckos in cages A and B did not show the territory-marking behaviour (Table 1). The only marks laid by these animals were faeces. Defaecation always occurred in a specific location which was constant throughout the whole observation period in every vivarium. This location was determined by the dominant male and used by every animal in the cage.

Table 1: Territoriality as expressed by males of *Eublepharis macularius*

Cage type	Total observations	Marking	Combat *	Licking **	Smearing **
A	35	0	0	1	0
B	35	0	0	1	0
C1	35	35	17	11	4
C2	35	35	6	12	1

*All combat won by dominant male
**(dominant) male only

The dominant males in cages C_1 and C_2 (animals 1 and 2) exhibited a pattern of marking using their whole body. They licked the secretion from their preanal glands and then smeared it all over the body by means of their tongue. This in both cases followed a pattern: They first start spreading the secretion on the leg, and as far as they can on the flank. The same procedure is repeated on the other side. This procedure took four minutes in the first and three minutes in the second male which was considerably smaller (snout-vent length of animal 1: 134 mm, of animal 2: 11.5 mm); and was performed only once on each side of the body. After this, the animals started moving, but this time rubbing their flanks extensively on the larger stones surrounding their heating territory. This action has been observed four times in animal 1 and once in animal 2 (out of 35 observations in each case). The non-dominant males in both the cages never showed any territory marking or "smearing" habit.

DISCUSSION

Territory marking behaviour by scent is a common feature amongst animals, and especially in geckos where the Jacobsen's organ is well developed (Henkel and Schmidt, 1991). The olfactorial senses are considered important in locating food and intraspecific communication as well as mating. As *Eublepharis macularius* mainly rely on their olfactorial organs for recognizing their surroundings, sound is of limited use in territory marking. Nevertheless, both males and females are capable of emitting sound (Hotz, 1969), but this is probably restricted to intersexual communication.

As shown by the above observations, the expression of territoriality seems to be dependent on the presence of other males as in the cages with only one male (types A and B), no marking behaviour was observed. The presence of another male resulted in a full display of territorial marking behaviour.

Walking with stiff legs with the body raised high is presumably meant to be an intimidation display as described by Wilms (1989). In other reptiles, such intimidation displays are achieved through other means, including throat inflation (Carpenter and Ferguson, 1977). In contrast to observations on other reptiles such as the south Indian flying lizards *Draco dussumieri* (John, 1970), the intimidation display of *Eublepharis macularius* is not meant to be a simple bluff as biting is always part of a fight and it occasionally results in open wounds. All the combat observed demonstrated that the dominant male is always the winner. Fightings in others reptiles, such as the rainbow skink (*Carlia rostralis*) for example, often show no clear winners (Whittier and Martin, 1992).

In *Eublepharis macularius*, tail-wagging is an important means of communication as it is always used when two animals, males and females alike, meet one another. In contrast to this, Johnson and Brodie (1974) found that in *Coleonyx varegatus*, tail-wagging is confined to male-female intereactions exclusively. Further, the leopard gecko wags and vibrates its tail when the animal is about to catch an insect. The same display occurs during combat between two males before attack.

The habit observed of 'smearing' observed in the two individual males could be termed "polishing" as it shows some similarities to the action described by De Haan (1982) and Steehouder (1984) in the snake genera *Malpolon* and *Psammophis*. It seems that such a behaviour has never before been described in any other reptiles (De Haan, *pers. comm.*). "Polishing" seems to be the appropriate term to be used, as this act looks like a cat grooming itself.

While there are some differences in the expression of this behaviour in snakes and geckos, the similarities are striking. It is the fact that both animals smear their secretion over their body and that they are obviously using it for marking their territory. The differences are that in snakes the secretion is a fluid and not a waxy secretion as it is in case of the gecko. Additionally, in snakes, it is secreted by nasal glands and spread directly on the body without the aid of the tongue. Unlike in the snakes,the gecko's tongue is rough and also broader and thus seems to be the appropriate tool for smearing the waxy secretion.

It probably does not seem appropriate to compare two relatively distantly-related animal groups on the grounds of behavioural aspects. But considering that the snakes and the geckos dealt with inhabit dry and semi-arid areas of the Old World, it is tempting to draw the conclusion that the behavioural aspects are due to life in these regions and thus a parallel evolution of similar habits.

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DISTRIBUTION, POPULATION DENSITY, AND EXPLOITATION OF THE WATER MONITOR (*VARANUS SALVATOR*) IN THE PHILIPPINES

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(with one text figure)

ABSTRACT: The distribution of the three Philippine subspecies of *Varanus salvator* (*V. s. marmoratus*, *V. s. nuchalis*, *V. s. cumingi*) was investigated. Observations on their population status in the areas visited are given and reasons for their decline discussed. The negative impact of commercial hunting on the population densities is emphasized.

INTRODUCTION

All but the smallest and most remote Philippine islands that have vegetation and fresh water, are populated by water monitors (*Varanus salvator*). Population density varies significantly between different regions, being usually low in most places. Habitat destruction, as well as commercial and subsistence hunting, are factors thought responsible. Data on former population densities are unavailable. Repeated expeditions to a number of different regions in the Philippines have provided the basis for an evaluation of the present situation with respect to the status of the species, as well as the reasons for population declines.

METHODS

Between 1984 and 1991, five field trips were made to the Philippines. The following islands were visited: Basilan, Bohol, Busuanga, Calauit, Cebu Leyte, Luzon, Masbate, Mindanao, Negros, Palawan, Panay, Samar, Siquijor, Ticao, and the Sulu-Islands Bongao, Sanga Sanga, Siasi, Sibutu and Tawitawi (for geographical locations, see Fig.1). The time spent on each island varied from one week to several months.

For each of these islands the subspecies of water monitor was determined (for descriptions and differences see Mertens, 1942a-c; Gaulke, 1991). Information concerning the nature and extent of exploitation was obtained from discussions Department of Environment and Natural Resources (DENR) personnel, hunters, skin dealers and leather manufacturers, as well as visits to public markets. Population status was evaluated through sightings of lizards or their tracks, in some places with the aid of trapping, and with the assistance of local inhabitants. In particular, older people and hunters provided interesting personal experiences regarding the frequency of monitor lizard sightings/catches in former times and at present. Notes on the habitat types of the lizards were made in all areas surveyed.

RESULTS

Distribution

Varanus salvator marmoratus occurs on the islands of the Tawitawi and Jolo groups, while on Basilan a darkish form of *Varanus s. cumingi* is distributed, very similar to that from Leyte and Samar (see Fig. 1). Description and photo of these taxa can be found in Gaulke (1991).

The discovery of *V. s. marmoratus* as far west as Sibutu Island (only a few kilometres off the coast of Sabah), is remarkable. As with *V. s. cumingi* and *V. s. nuchalis*, this subspecies was considered to be endemic to the Philippines. The new record makes its occurrence on Sabah, on north-eastern Borneo, likely. Otherwise, the distribution disjunction within the Philippines (from Palawan up to Luzon in the north, and on the Sulu-Islands in the south) appears inexplicable. The occurrence in Sabah is supported by two photographs of water monitors taken by Romulus Whitaker in Sabah: these show a very dark form, as is 'diagnostic of' *V. s. marmoratus* (see Gaulke, 1991). However, scalation features cannot be deter-

mined from the photos, and thorough taxonomic studies of the Bornean water monitors need to be conducted. At present, only the nominate form is reported from this large island.

These records strongly support the assumption of Gaulke (1991) that *V. s. cumingi*, the most derived of the Philippine water monitors, did not originate from Borneo. On both former entryways from Borneo, the Palawan and the Sulu land bridges, occurs *V. s. marmoratus*. As is extensively discussed in Gaulke (1991), both forms (*V. s. marmoratus*, and *V. s. cumingi*) differ significantly from each other not only in colour pattern but also in several scalation features, a close affinity can be excluded. The recently discovered distribution border between both forms (Basilan/Sulu-Islands, see Fig. 1) is another indication for their separate origins.

Population Status

The most intensive study concerning water monitors in the Philippines was carried out on Calauit Island, in the years 1984/85 (Gaulke, 1989b). About eight months were spent on this small island (3760 ha.), which is a wildlife sanctuary since 1976. For this reason, disturbances caused by people were negligible (only the wildlife wardens and their families live here), and the habitat was largely intact, with mangrove and coastal forests at the shoreline, and dipterocarp forest in the hilly hinterland. Agricultural areas in use up to 1976 were abandoned and allowed to revert back to wild habitat.

By the capture/recapture method the number of adult lizards on this island was calculated to be 913 (± 131). Comparisons between the trapping results from the different habitats showed that by far, the highest population density was reached in the coastal areas, especially the mangrove swamps, a much lower density in the dipterocarp forest, and a negligible density in the savannah areas. During my study on Calauit, water monitors were sighted on almost every walk.

In their preferred habitats, several animals could usually be seen within a few hours.

On almost all other islands visited, the situation was quite unlike that known in Calauit. Even so, at least a few days on each island were spent surveying preferred habitat types of water monitors (swamp areas, densely vegetated river or creek banks), the results were rather negative. On Bohol, Busuanga, Leyte, Panay, Samar and Siquijor no direct sightings were made (time spent on each island one to two weeks). The presence of water monitors could only be determined with the help of local people trapping or hunting them. On most other islands very few direct sightings could be made (Basilan, Cebu, Luzon, Masbate, Mindanao, Negros, Palawan, Siasi and Ticao), averaging less then one monitor lizard per week. During a 14-day stay in Zamboanga del Norte/Mindanao trapping experiments were conducted. They were carried out in the Gumay river area, which according to the local DENR office, as well as information from local inhabitants, was considered to be the best place for water monitors in the entire region. In this Gumay river area, one trap needed to be operated for 27.5 days (the average, calculated from the number of traps, the time they were operated, and their success) to yield one catch. On Calauit, a trap had only to be operated for 7.9 days for one catch (this figure includes the traps set in the dipterocarp forest and even the savannah areas where almost nothing was caught throughout the entire stay on Calauit).

In almost all areas visited, older people told me that water monitors used to be far more abundant during their youth than they are now. On several occasions, young men, hearing that I was looking for water monitors, offered to bring as many as I could possibly desire. However, most failed to bring even one, or turned up with other animals like *Hydrosaurus pustulatus* or *Gekko gecko*.

The local DENR officers were usually aware of the decreasing water monitor popula-

tions within their district, warning me that I would probably not see any.

The only area which might be comparable to Calauit in regard to the water monitor population density (thus no trapping experiments took place there), were some islands of the Sulu Archipelago (Sibutu, Tawitawi, Sanga Sanga, Bongao). Up to seven water monitors could be sighted within half a day at this site, even if I was not especially looking for them! They were located in different types of habitat: coconut groves, coastal forests and secondary forests, sometimes in the direct vicinity of human dwellings.

It can be summarized that population densities of *Varanus salvator* in most parts of the Philippines are very low, compared to the wildlife sanctuary at Calauit Island. This comparison, as well as the observations of local inhabitants suggest that the scarcity is not a biological phenomenon. Populations must have decreased substantially over several decades and the process is continuing.

The following two sections deal with the probable reasons for this decline.

Habitat Destruction

About 200 years ago, the Philippine Islands were still almost totally covered by forests: mangrove and nipa forests in the coastal swamp areas, littoral forest on the sandy coasts, and different types of dipterocarp and cloud forests in the mostly hilly or mountainous hinterlands (Dusik, 1986). Now only small relics of the original vegetation types are left. Bicol Province in southern Luzon, with 218,300 ha. of primary forest, is one of the largest forest areas today (Auffenberg, 1988).

Mainly as a result of rapid human population growth, the forests have been converted to agricultural areas (e.g., coconut and banana groves, rice and corn fields), for the expansion of towns/cities as well as the creation and enlargement of villages. After logging and burning, large areas have been turned into infertile savannah or have become barren. Not only have the commercially valuable dipterocarp forests been destroyed, but also the mangrove forests. The swampy areas are mainly used for raising fish and for growing rice.

On a number of islands, deforestation has been total. Affected are larger islands such as Cebu and Masbate, as well as smaller ones like Ticao, Siasi or Bongao. On others, for example Palawan, Mindanao, Negros, Busuanga and Tawitawi, there is still some forest left. However, logging and burning continues at an almost unbelievable pace and even the few protected areas are not spared.

Exploitation

The Philippines is a member of the Convention on International Trade in Endangered Species of Fauna and Flora (CITES), and since all monitor lizards are listed on Appendices I and II, their trade is controlled by international agreements. In addition, wildlife in the Philippines is protected by national legislation. With a decree of the DENR (April 21, 1986) the export of all wildlife and wildlife products was banned. Later, this ban was modified, becoming valid only for species listed on Appendix 1 of CITES (therefore not including *Varanus salvator*), while the trade in the other wildlife was subjected to strict control. Since then the trade and hunting of water monitors is again almost completely banned. Unfortunately, the effect of this ban is marginal and illegal trade flourishes. It is now impossible to receive any reliable wildlife trade data from the Philippines.

Water monitors are exploited for different reasons within the Philippines:

1. Water monitors are occasionally killed near villages because they prey on domestic chicken. However, this is not a significant pressure on monitor populations.

2. In most areas of the Philippines, at least a small percent of the human population values the meat of water monitors. Normally it is eaten

as "pulutan" (snack) by the men while drinking. However, in some cities like Puerto Princessa (Palawan) or Culasi (Panay), monitors are sold at public markets and elsewhere. Small restaurants in Manila offer monitor lizard meat, which must originate in other regions. However, the commercial meat trade is not large and does not play an important nutritional role. In fact, a large number of Filipino respondents were quite taken back by the thought of eating lizard meat.

3. The skins of water monitors are processed by the souvenir industry. Normally, the entire skin is used for the production of stuffed monitors. A few years ago they could be found in large numbers on the souvenir markets of Manila (e.g., Pistang Pilipino) and Cebu. Their price varied between 100 and 200 Pesos (currently about U.S. $4-8), depending on the size. In 1990, raids were carried out by the Protected Areas and Wildlife Bureau (PAWB), during which these items, as well as sea turtle shells, stuffed tortoises and other articles were confiscated. In 1991, when I last visited the Pistang Pilipino, a noticeably reduced number of stuffed animals were on sale compared to 1988/89. Since then there are indications that numbers are rising again.

4. Lastly, and most importantly, water monitors are hunted and trapped for the leather industry. Their leather is used for the production of watch straps, purses and belts. Some of these are made in the Philippines, but the major quantity of skins leave the Philippines for processing abroad. As mentioned above, trade numbers are not available due to the illegality of the business. However, data obtained show that the trade is very large (Table 1), and was on the increase up to 1985. The disparity between export and import data is due to the fact that export from the Philippines has been largely uncontrolled. The actual trade volume was and is significantly higher than what this table shows. The main importing country is Japan.

Skin dealers in Metro Manila and other locations, as well as hunters on Negros, Busuanga, Bohol, Cebu, Luzon, Mindanao and Palawan were interviewed. They normally have several groups of hunters working for them on different islands. These groups are visited at regular intervals to buy their stocks, and are paid by the inch or per animal, and normally do not receive more than about 20 Pesos (approximately U.S. 75 cents) for a medium sized lizard. Both groups, the hunters and the dealers, complain that it is becoming more and more difficult to work profitably, since water monitor populations are steadily decreasing. This means that they have to continually explore new trapping areas.

Exploitation factors 2, 3, and 4 are not mutually exclusive. Often the meat, as well as the leather, is used. Many of the dealers only buy live lizards, since the hunters usually do not know how to process the skin.

TABLE 1: Trade in skin and leather items of *Varanus salvator* in the Philippines in the years 1980 to 1985, summarised from WTMU lists.

Year	Exported from the Philippines	Imported from the Philippines
1980	–	3999 skins, 1454 items
1981	–	2834 skins, 4762 items
1982	–	3000 skins
1983	2607 skins	682 items
1984	2802 skins, 417 items	3987 items
1985	84 skins	80356 skins, 1638 items

DISCUSSION

Without doubt, habitat destruction is one of the most important factor for the decline of the endemic fauna and flora in the Philippines.

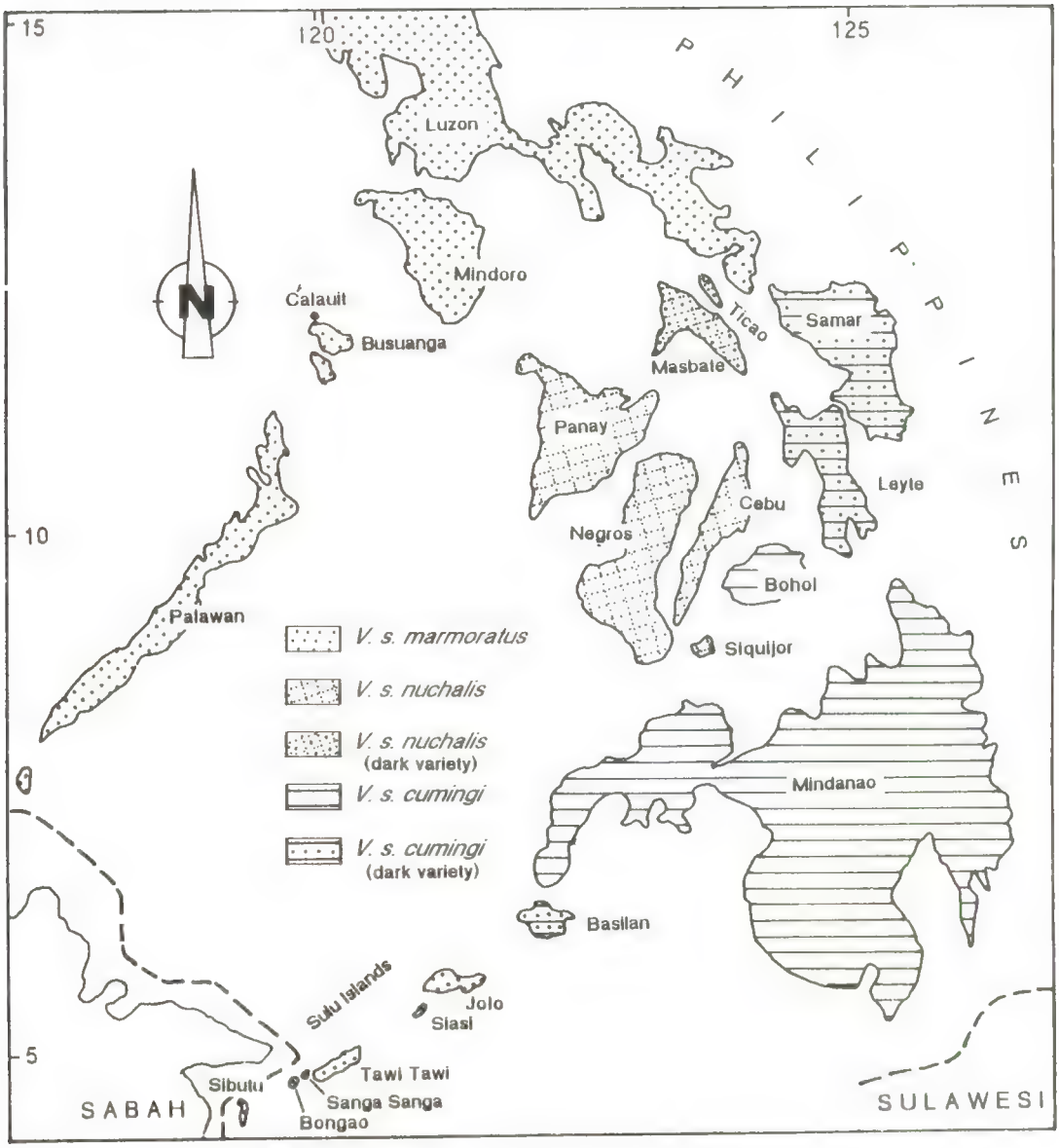

FIGURE 1: Distribution of *Varanus salvator marmoratus*, *Varanus salvator nuchalis* and *Varanus salvator cumingi* in the Philippines.

However, for the decrease of the water monitor populations, other factors appear to be more important.

As an indicator, the international dimension of trade with skins of water monitors from different countries can be mentioned (Luxmoore and Groombridge, 1989), together with the fact that in countries were water monitors are not hunted such as Sri Lanka, they are very abundant, despite habitat destruction. There they have adjusted to the encroachment of civilization on their orginal habitats and are found even within villages and cities (e.g., Jirousek 1983; Munsch, 1987).

The strong correlation between exploitation and population decline for *Varanus salvator* can now be established for the Philippines. The much higher density on the islands of the Sulu Archipelago cannot be explained by environmental factors. Cultivation here is as advanced as in other parts of the Philippines, with the same types of natural and substitute habitats (secondary growth, different types of plantations and some swampland).

However, there are differences between the Sulu Archipelago and the rest of the country. While about 90% of the Filipinos are Christians, the Sulu Archipelago is the last remaining region with a Moslem-dominated population (about 90 - 95%). As the Islamic religion forbids the eating of monitor lizards, this form of exploitation does not occur here. Skin dealers have probably not explored the region due to political/religious reasons. The Sulu-Archipelago is viewed with apprehension by most Christians as a simmering hotbed of unrest (e.g., Werning, 1991). Dramatic outbreaks of violence in the past have claimed thousands of human lives.

Since the hunting and trade ban alone seems to have little effect, other methods should be tried to help the people as well as the lizards. A worthwhile project would be to start commercial water monitor farming as an alternative to the exploitation of wild stock. This form of farming has worked very well for different kinds of crocodiles (see Suvanakorn and Youngprapakorn 1987; Onions, 1987), and in several countries wild populations began to increase due to the economic incentive to protect habitats and the crocodile resource therein.

Pilot water monitor breeding projects have begun in Palembang, Sumatra (Erdelen, 1991). One of the biggest problems is the long incubation time of monitor lizard eggs (several months), in addition to their extreme susceptibility to fungal or bacterial infections during incubation. However, the breeding results obtained at the Madras Crocodile Bank (Andrews and Gaulke, 1990) show that such problems can be overcome (Andrews, 1991).

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SOME ASPECTS OF THE BREEDING BIOLOGY OF THE BLACK SOFTSHELL TURTLE, *ASPIDERETES NIGRICANS*

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ABSTRACT: The breeding biology of *Aspideretes nigricans* was studied Chittagong (Bangladesh) during 1985. This paper reports nesting activities, eggs and incubation. Clutch size ranged between 12-38, and a positive relationship was found between female body size and clutch size. Incubation in wild nests ranged between 73-108 days, the short incubation period indicating that no developmental arrest takes place.

INTRODUCTION

The black softshell or Bostami turtle *Aspideretes nigricans* (Anderson, 1875) is endemic to Bangladesh (Annandale and Shastri, 1914; Khan, 1980) and is associated with the Mohammedan shrine of Sultan al-Arefin Hazrat Bayazid Bistami (popularly known as Bayazid Bostami). The turtle enjoys religious protection and individuals cannot be removed or killed. Some information on its biology is available in the literature (see Ahsan and Haque, 1987; Ahsan and Saeed, 1989; Ahsan *et al.* 1991; in press), therefore an attempt was made to study some aspects of its breeding ecology.

METHODS

The breeding ecology of *A. nigricans* was studied in the Bayazid Bostami area at Chittagong (Bangladesh) in 1985. Eggs were collected from 11 clutches, measured, divided into batches, and transplanted into three incubation sites. These were: (1) natural nesting site (NS), (2) an artifically-made nest in the Animal Breeding House (AH) of the Zoology Department of Chittagong University, and (3) an artificially made nest in an open area near the Science Teacher Lounge (SL). The soil in these artificially made nests was sandy-loam and physically similar to that of the natural habitat. Eggs were placed at about the same depth as they were found in the original nest. All nest sites were marked for later recognition of the exact location. Nest sites of AH and SL were visited regularly and moistened with water when necessary. NS was inspected occasionally. After 60 days of incubation, each nest was excavated weekly to check for hatching and after hatching began this exercise was repeated daily. After two weeks, from the first day of hatching in a particular nest, all unhatched eggs were opened to determine the percentage of undeveloped eggs and dead embryos.

RESULTS AND DISCUSSION

Gravid females emerged from the pond during the post meridian hours completed egg-laying activities between 1620 and 1920 hours (Table 1) and returned to the pond within 15 minutes. Females took a relatively long time to select a suitable nesting site compared to nest excavation, egg-laying and sealing of the nest (Table 1). Nest characteristics (Table 2) varied depending on the size of the gravid female, clutch size and nesting place. Ovipositing females were smaller than non-laying ones, i.e., turtles that did not emerge from the pond (Table 3) which is an unusual characteristic for any population of turtles. The mean clutch-size was 20.4 (range 12-38, $n = 17$) in 1985 which is close to figures for 1984: mean 20 (range 16-24, $n = 6$) (Ahsan, *et al.*, 1991). Positive linear relationships were found between the size of the nesting female and clutch size: carapace length and clutch-size ($r = 0.817$, $P < 0.01$), carapace width and clutch-size ($r = 0.846$, $P < 0.01$), and body weight and clutch-size ($r = 0.94$, $P < 0.01$). On the other hand, the relationship between clutch-size and nest upper surface diameter was weaker ($r = 0.752$, $P < 0.05$), while clutch-size and mid-nest

TABLE 1: Nesting time parameters of the black softshell turtle (n = 8).

Clock time	Mean	Minimum	Maximum
Gravid female emerging	17:24	16:20	18:10
Start of nest excavation	18:06	16:45	18:50
End of egg-laying/start of nest-sealing	18:08	17:02	19:10
End of sealing-nest	18:17	17:12	19:20
Time taken in minutes			
To find nest site	41:88	25:00	60:00
To excavate nest	12:75	10:00	20:00
To lay eggs	10:00	5:00	15:00
To seal nest	8:38	5:00	10:00

TABLE 2: Nest characteristics of the black softshell turtle. Length in cm; weight in gm.

Characteristics	Mean	Minimum	Maximum	n
Nest surface diameter	15.5	12.0	20.0	7
Nest mid diameter	15.8	14.2	17.0	7
Nest depth	16.6	14.0	20.8	7
Egg weight	24.5	20.0	29.0	105
Egg diameter	3.4	3.2	3.6	105

TABLE 3: Size of females and hatchlings of the black softshell turtle. Length in cm; weight in kg.

	Mean	Minimum	Maximum	n
Nesting females				
Carapace length (CL)	48.2	40.0	58.0	10
Carapace width (CW)	40.1	33.0	47.0	10
Body weight (BW)	12.6	9.1	18.1	5
Non-nesting females				
CL	63.5	50.0	73.0	10
CW	56.4	43.0	65.0	10
BW	27.6	20.0	42.0	10
Hatchling				
CL	4.7	4.5	5.1	10
CW	4.1	4.0	4.2	10
BW	16.4	14.3	17.9	10

diameter ($r = 0.484$, $P > 0.05$) showed no relation, and clutch-size and nest depth ($r = 0.1$, $P > 0.05$) no relation. Egg-size and egg-weight relationship was strongly positive ($r = 0.9$, $P < 0.05$).

Incubation and hatching parameters varied among the three incubating sites (Table 4) and variation was observed within each incubating site. In the natural habitat, the incubation period varied from 93 to 108 days (mean 97.2) in this study of 1985 compared to 96-104 days in 1984 (Ahsan *et al.*, 1991). The short incubation period indicates that no developmental arrest is evident. Although we did not record the temperature and rainfall at the site, the nearest weather station data during the study period gives an indication of these conditions (Table 5). We did not find any significant differences between monthly mean temperatures and total rainfall of 1984 and 1985 (monthly minimum mean temperature: $t = 0.288$, $P > 0.05$ and maximum mean temperature $t = 0.256$, $P > 0.05$; and monthly total rainfall $t = 0.393$, $P > 0.05$). Therefore, the actual cause of variation in incubation time is unknown but sample size may be a contributory factor.

Table 4 shows that the hatching success varied between the three incubating sites and in AH it was the highest where there was no predation, eggs being protected. Low hatching in the NS was due to various factors including high predation, erosion and inundation of nest

TABLE 4: Incubation and hatching of the black softshell turtle.

	Natural Nesting Site (n = 162)			Animal Breeding House (n = 44)			Science Teacher Lounge (n = 57)		
	Mean	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.
Transplanted eggs	14.7	6.0	22.0	8.8	6.0	13.0	9.5	8.0	12.0
Eggs hatched (%)	38.9	0.0	77.8	68.2	0.0	100.0	45.6	0.0	87.5
Eggs damaged/ undeveloped embryo (%)	22.2	0.0	85.7	22.7	0.0	50.0	22.8	0.0	70.0
Dead embryos (%)	8.6	0.0	37.5	9.1	0.0	50.0	15.8	0.0	55.6
Predation (%)	30.3	0.0	100.0	0.0	0.0	0.0	15.8	0.0	100.0
Incubation (days) n = 63, 30, 30 respectively	97.2	93.0	108.0	88.8	81.0	105.0	91.9	85.0	99.0

TABLE 5: Mean temperature and total rainfall of Patenga (Chittagong) in 1985*.

Month	Temperature (°C)		Rainfall (mm)
	Minimum	Maximum	
February	15.1	27.8	6
March	21.7	30.0	88
April	24.6	31.5	143
May	23.9	32.0	511
June	24.9	31.6	464
July	24.4	30.4	1044
August	25.0	31.6	451

*Data from Bangladesh Meteorological Department

by rain-water. Although predation was high in the NS sample, dead embryos were fewer. The highest number of dead embryos were found in the SL, the cause being unknown. Numbers of underdeveloped or damaged eggs were uniform in all sites. Two dead hatchlings (6.7%) were found in the bottom of a nest at SL which is possibly due to compaction of soil. The jungle crow (*Corvus macrorhynchus*), domestic dog (*Canis familiaris*) and domestic cat (*Felis catus*) were seen to predate eggs. Nocturnal mammals, including jackal (*Canis aureus*), jungle cat (*Felis chaus*), civets and mongooses are also suspected predators. Sometimes eggs are also destroyed by humans.

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STUDIES ON THE REPRODUCTION OF THE INDIAN SOFTSHELL TURTLE, *ASPIDERETES GANGETICUS*

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ABSTRACT: A study was conducted on the Indian softshell turtle (*Aspideretes gangeticus*) in captivity in Gujarat State, western India. Courtship, mating and nesting behaviour are described herein. A male was territorial and aggressive towards conspecific males during the breeding season between April and May. Egg-laying by a female was observed in October, when 22 eggs were laid in a nest. Incubation period was 260 days.

INTRODUCTION

The Indian softshell turtle *Aspideretes gangeticus* (Cuvier) is widely distributed in Gujarat, Rajasthan, Punjab, Uttar Pradesh, Madhya Pradesh, Bihar, Orissa, West Bengal in India and also in Pakistan, Nepal and Bangladesh (Das, 1991). A large number of this species are caught from the wild and sold in the markets (Moll, 1984; Rao, 1985). Presumed threats to the species include (i) capture of turtles and collections of eggs for food, (ii) use of river beds for cultivation of cucurbitaceous fruits and vegetables and other crops, and (iii) river pollution.

At present, there are a few breeding centres under the Ganga Pollution Control Project. Little information is available in the literature on the breeding biology of this species. The present study on captive *Aspideretes gangeticus* was carried out from January 1989 to July 1991 to obtain new informations on the breeding biology of the species.

MATERIAL AND METHODS

We kept six turtles (2 males and 4 females) in a gharial (*Gavialis gangeticus*) pond for observation. All turtles were fed on dead fish and chopped meat. The males are recognisable in possessing a longer and thicker tail. Additionally, males are territorial during the breeding season.

The enclosure is a 6400 sq.m. area with an irregular pond of 100 sq.m. with a 90 cm depth in the centre and continuous supply of slow running water. Two sides of the enclosure were sloping and covered with vegetation, with the other two sides flat with a sandy platform for basking.

OBSERVATIONS

Courtship and mating behaviour

During the months of April and May, territorial behaviour was exhibited by the larger male. This dominant male charged and bit the neck, limbs, and posterior part of carapace flap of the other smaller turtle. Sometimes the large male mounted the other male, tried to push it down and bit it on the neck, holding on for varying periods. Subsequently, the smaller male left the main pond and hid nearby in a small muddy puddle. Such combat continued during the entire breeding season.

When the territorial male found a receptive female, he approached and blocked her path. Then he moved closer by slowly swimming in circles until finally mounting her. Mounting is accomplished by grasping the female with its claws hooked over the fore limb of the female. The hind limbs grasp the ventral side of the female's carapace flap. This takes 4 to 5 minutes.

After mounting, both turtles float, singly or simultaneously protruding their heads to

breathe. The male alone squirts water through the nostrils. After 30 - 50 minutes the mating ceases and the female escapes.

Nesting and egg-laying behaviour

On October 12, 1990, a female came out of the water at 1700 hours, went into the area with vegetation and found a nesting place, 3.5 m away from the water and 0.5 m above the slope from the water. She excavated a pit with the hind limbs. Both limbs were used alternately to dig and shovel. She took one and a half hours to construct the pit. After excavation, she rested on it for three minutes, while the cloacal region showing pulsating movements. Then she laid the first egg. Other eggs were laid at intervals of 20-40 seconds. Following laying of the last egg, she carefully arranged the eggs in the cavity using both hind limbs. The hind limbs were then used to cover the eggs in the nest. The entire nesting process from excavation to covering and camouflaging took 2.5 hours.

Another small female (carapace length with flap 43 cm) laid 13 eggs on October 9, 1990 in a gunny bag while being transferred from a pond: (in this case, the exceptionally small clutch size may be due to disturbance or small size of the female).

Egg and nest dimensions

On the second day following egg laying, the nest was carefully opened for taking measurements. It was flask-shaped, measuring 23 cm x 16 cm at the centre with a 8 x 12 cm narrow entrance. The first egg was found at 12 cm depth.

All the 22 eggs were spherical and brittle-hardshelled with average dimensions 30.8 x 30.8 mm and 10.5 gm weight (Table 1).

Hatching

The eggs started hatching after 260 days of incubation. The first hatchling emerged on the

TABLE 1: Clutch and egg sizes of the Indian softshell turtle. Length in cm; weight in gm.

Clutch and date	Number of eggs	Length		Width		Weight	
		Range	Mean	Range	Mean	Range	Mean
Clutch-I 9.10.1990	13	3.20-3.43	3.34	3.20-3.37	3.28	12-15	12.8
Clutch-II 12.10.1990	22	3.00-3.17	3.08	2.95-3.15	3.08	9-12	10.5

TABLE 2: Size of hatchlings of the Indian softshell turtle. Length in cm; weight in gm.

Number	Carapace length		Carapace width		Plastron length	Shell depth	Weight	Occeli on carapace
	curved	straight	curved	straight				
1.	4.50	4.30	4.00	3.60	3.20	1.40	09	6
2.	4.50	4.30	4.30	3.70	3.20	1.30	11	3
3.	4.30	4.30	4.30	3.70	3.20	1.40	10	4
4.	4.60	4.45	4.20	3.80	3.30	1.50	10	5
5.	4.70	4.70	4.20	4.05	3.55	1.45	10	Dark carapace
6.	4.70	4.70	4.20	4.00	3.50	1.50	12	4
7	4.55	4.35	4.20	3.75	3.25	1.35	11	6
Mean	4.54	4.44	4.22	3.80	3.31	1.41	10.4	

morning of June 29, 1991 at 0645 hours, three others came out within the next hour. The remaining three hatchlings emerged within the next 33 minutes. In total, seven hatchlings were obtained from the nest within one hour and 33 minutes. The hatching success was 33%. After 10 days, the nest was opened and the remaining eggs were examined and found to be infertile.

All the seven hatchlings were bright olive green with three to six eye-like markings on the carapace, three to five black lines and a black stripe ran behind the eyes and other posterior of the forehead. The size of the hatchlings ranged from 4.30 - 4.70 mm carapace length and weighed 9 to 12 gm (Table 2).

All hatchlings were kept separately in rearing pens. They were fed on small live fishes, tadpoles and chopped meat.

DISCUSSION

During the study period, the breeding season was from April to May, supporting the observations of Das (1985). During the season, of courtship and mating the larger male dominated its smaller conspecific male and exclusively courted the females.

According to Das (1991) the species lays 25 to 35 eggs in all months of the year, except February to April. In this study, a female laid 22 eggs in October. The nesting season is a little early and the clutch size smaller than that given by Das (1991).

ACKNOWLEDGEMENTS

The authors are grateful to V. A. Jadeja, Sayaji Baug Zoo, Vadodara, for providing facilities.

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MICROHABITAT RELATIONS OF SOME SNAKES AND LIZARDS IN TAMIL NADU, SOUTH INDIA

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(with two text figures)

ABSTRACT: The microhabitat niche dimension was examined for the reptile assemblage in an agricultural/scrub landscape. Clustering of species in microhabitat 'niche space' indicates the existence of spatial guilds. Such guild structure is demonstrated and illustrated here by means of UPGMA and PCA methods.

INTRODUCTION

Fieldwork was conducted in Chengai Anna District of Tamil Nadu, centred around Vadanemmeli and neighbouring villages, ca. 40 km south of Madras, South India, in July and August, 1990. The area studied is low-lying, flat coastal land, mostly farmed but also with extensive *Casuarina* plantation and scrubland. Specimens of nine species of snake and five species of lizard were caught, and records kept as detailed below to enable statistical analysis of microhabitat use as detailed below. Three snake species (*Eryx johnii*, *Xenochrophis piscator* and *Naja naja*) and three lizard species (*Mabuya bibroni*, *Lygosoma punctata* and *Chamaeleo zeylanicus*) were caught in numbers inadequate to allow useful analysis.

MATERIAL AND METHODS

Individual lizards and snakes were caught by hand, many having been found by tracking and/or dug out of burrows by the late Chokkalingam, a local snake catcher. Microhabitats were initially recorded in considerable detail for each animal caught. From these detailed description, specimens were assigned to a few broad microhabitat categories defined so as to give enough meaningful distinct classes with adequate sample sizes of individuals in each for useful statistical manipulation. As opposed to human pre-assignment of microhabitat categories, this process effectively uses the reptiles themselves as a bioassay to determine categories.

For the community-level analyses, a resource state matrix (Table 1) was used with those species with more than five individuals recorded for analysis. The *Calotes versicolor* results were split between two Operational Taxonomic Units (OTU's) because the microhabitats occupied by adults and juveniles were apparently quite different. From the resource state matrix, I calculated niche overlap for each pair of OTU's using the Pianka index,

$$\phi_{ih} = \frac{\Sigma p_{ij} p_{hj}}{\sqrt{\Sigma p_{ij}^2 \, \Sigma p_{hj}^2}},$$

where P_{ij} and P_{hj} are proportions individuals of species i and h respectively occupying microhabitat category j (Pianka, 1973). These overlaps are given in Table 2. I then used these overlap values to examine some aspects of community structure, following the procedures outlined below.

Specifically for the purpose of identifying clusters of ecologically similar species, I applied the UPGMA clustering technique (unweighted pair-group method using arithmetic means) to the overlap matrix. To give an indication of significance of clusters, I calculated some of the major percentiles; the overlap value corresponding to the xth percentile is that exceeded by x% of the pairwise overlaps measured; for example the median overlap gives the 50th percentile. This procedure will facilitate comparisons between this com-

munity and others which may be studied, compensating for the fact that difference in detail of overlap calculation methods can have marked systematic effects on actual overlap values.

Following Inger and Colwell (1977), I performed a Principal Components Analysis on the overlap matrices. This is a useful descriptive technique, showing the maximum amount of multidimensional set of nearness relations in the minimum number of descriptive dimensions necessary. Since three dimensions can be shown satisfactorily in a diagram, this allows a less distorted picture than clustering techniques, which are limited to one dimension.

RESULTS

The UPGMA dendrogram shows adult *Calotes versicolor* with the snake species *Dendrelaphis tristis* and *Ahaetulla nasutus* forming a very distinct arboreal guild (Fig. 1). The other species cluster in pairs, with *Ptyas mucosus* and *Eryx conicus*, the two species often found in burrows, being well separated from the other, more clearly terrestrial taxa.

The results of the Principal Components Analysis are shown in Fig. 2; the fuller picture illustrates some points not clear from the UPGMA analysis. *Eryx conicus*, being a burrower, is well separated from the others, with Ptyas mucosus being the nearest neighbour, which includes *Amphiesma stolata*, juvenile *Calotes versicolor*. *Sitana ponticeriana* and *Echis carinatus*. The arboreal guild corresponds well to its depiction by UPGMA, although *C. versicolor* is more separated from the snakes. Both terrestrial and arboreal guilds are essentially linear.

DISCUSSION

From the UPGMA results we can see that, apart from the absence of lizards from burrows, lizards and snakes are generally to be found in similar microhabitats; thus guilds are not due to basic differences between major taxa in ability to exploit habitat. It would be interesting to examine the extent to which members of guilds rely on or compete with one another for food.

As examined by the Principal Components Analysis, guild structure (i.e., clustering of ecologically similar species) is apparent but loose. This can be compared to the herpetological assemblages examined by Inger and Colwell (1977) in Thailand; the assemblage here shows considerably more guild structure than the Thai agricultural as-

TABLE 1: Resource state matrix.

Species	Microhabitats					
	1	2	3	4	5	6
Amphiesma stolata	2	18	15	49	9	0
Calotes versicolor (juvenile)	1	0	2	4	0	0
Calotes versicolor (adult)	0	3	3	1	11	18
Sitana ponticeriana	0	10	4	6	12	0
Eryx conicus	10	0	1	0	0	0
Echis carinatus	1	0	0	5	14	0
Ahaetulla nasutus	0	1	0	0	0	8
Ptyas mucosus	3	0	0	2	2	0
Dendrelaphis tristis	0	0	2	0	1	7

Numbers refer to individuals of each species found in each microhabitat category (i.e., resource state). Microhabitat categories: 1 = burrows/holes; 2 = exposed ground; 3 = on ground at bunds/field edge; 4 = under dead vegetation; 5 = bund with vegetation cover; 6 = arboreal (including shrubs and hedges).

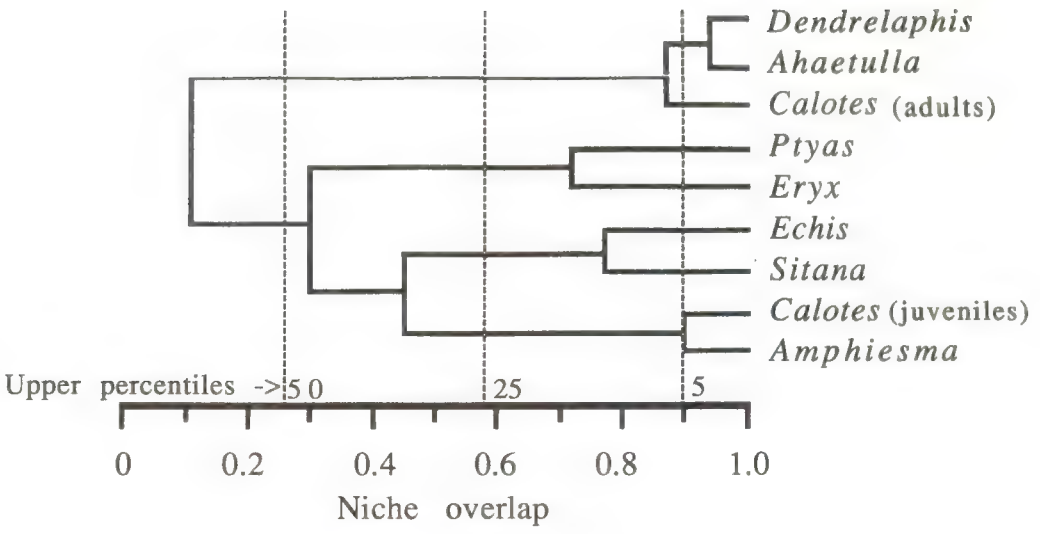

FIGURE 1. Cluster analysis (UPGMA). Dotted lines indicate 5th, 25th and 50th percentiles, as described in Methods.

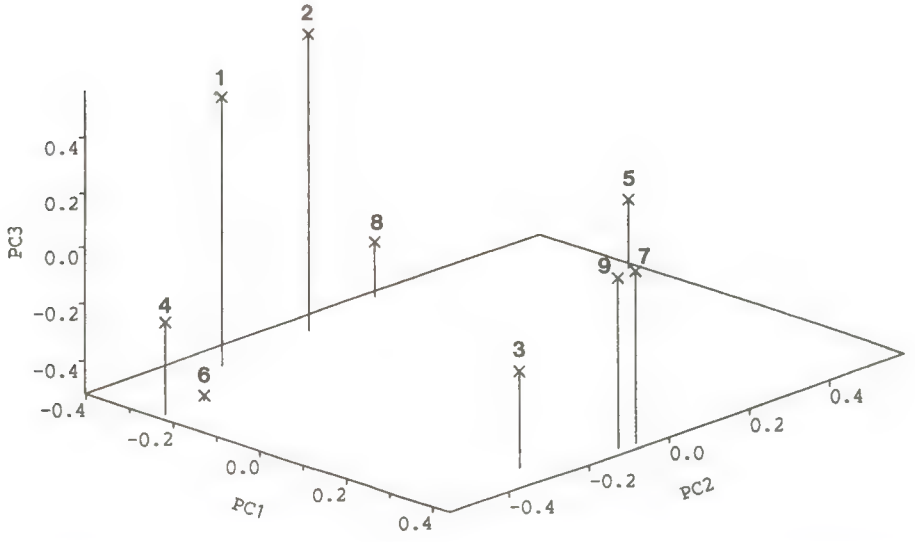

FIGURE 2. Three-dimensional Principal Components Plot. PC1, PC2 and PC3 are the first, second and third Principal Components, and explain 60.8%, 24.9% and 11.6% of the variance, respectively (97.4% of variance explained in total). Each x represents a species 'niche centre'; distances between these points will be inversely proportional to overlap.

Numbers code species as follows: 1 = *Amphiesma stolata*, 2 = juvenile *Calotes versicolor*, 3 = adult *C. versicolor*, 4 = *Sitana ponticeriana*, 5 = *Eryx conicus*, 6 = *Echis carinatus*, 7 = *Ahaetulla nasutus*, 8 = *Ptyas mucosus*, 9 = *Dendrelaphis tristis*.

TABLE 2: Niche overlap matrix.

Species	1	2	3	4	5	6	7	8	9
Amphiesma stolata	-	0.903	0.208	0.677	0.063	0.454	0.041	0.537	0.096
Calotes (juvenile)	0.903	-	0.101	0.406	0.261	0.308	0.000	0.582	0.119
Calotes (adult)	0.208	0.101	-	0.486	0.014	0.495	0.846	0.270	0.903
Sitana ponticeriana	0.677	0.406	0.486	-	0.023	0.772	0.072	0.507	0.158
Eryx conicus	0.063	0.261	0.014	0.023	-	0.067	0.000	0.724	0.027
Echis carinatus	0.454	0.308	0.495	0.772	0.067	-	0.000	0.667	0.128
Ahaetulla nasuta	0.041	0.000	0.846	0.072	0.000	0.000	-	0.000	0.945
Ptyas mucosus	0.537	0.582	0.270	0.507	0.724	0.667	0.000	-	0.066
Dendrelaphis tristis	0.096	0.119	0.903	0.158	0.027	0.128	0.945	0.066	-

semblage, but less than the Thai forest assemblages.

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NOTES

Hamadryad, Vol. 17, pp. 39-40, 1992

A RECORD OF *DRACO BLANDFORDII* FROM BANGLADESH

On a visit to the Sylhet University College Centre in 1985, I was informed by Mr. P. Dev, the head of the Zoology Department, of a locally-collected specimen of flying lizard in the Departmental Museum. Through the kindness of Mr. Hasmatullah, graduate student of Chittagong University, I was able to borrow this specimen in 1986.

The only record of species of the genus Draco from the People's Republic of Bangladesh is that of Khan (1987), who shot one in the Hazarikhil forest (22° 45' N; 91° 40' E), Bariadhala Range, Chittagong Forest Division, in south-eastern Bangladesh. Unfortunately, he failed to collect his specimen, and suspected the lizard to be *Draco maculatus*, a species known from south-east Asia from Myanmar (formerly Burma) to the Malay peninsula and Vietnam (see Musters, 1983; Welch *et al.*, 1990).

The Sylhet specimen, a female, showed the following characteristics: nostrils directed upwards, tympanum naked; forehead scales unequal and keeled; gular sac long and narrow; five patagial ribs; dark violet reticulated pattern on the middle and outer parts of the patagium. The specimen measured 76 mm in snout-vent length and 106+ mm in total body length (tail-tip missing). These characteristics are confined to *Draco blanfordii norvilii* (Alcock, 1895), according to the revision of the genus *Draco* by Musters (1983). However, an alternative scheme of classification exists (i.e., of Inger, 1983), which characterises *Draco blanfordii* as possessing nostrils that are obliquely (or dorso-laterally) oriented, but agree with Musters' (*op cit.*) other diagnostic features for this taxon, including five ribs on the patagium and dark transverse bands on the female patagium. The last observation has also been made by two separate workers (e.g., Smith, 1929; Biswas, 1967), based on material from adjoining north-eastern India.

The Sylhet material was collected from the vicinity of the Andarua haor marshes, about 2.4 km south of the Sylhet Railway Station (24° 53' N, 91° 55' E), close to Galimpur village, in Sylhet district. The collection area is hilly, the low-lying regions being inundated during the monsoons.

Further information on flying lizards from north-eastern Bangladesh was provided by Mr. M.A. Kader. On an excursion to a tea garden in Lakkatura near Tilagarh forest (24° 57'N; 91° 57'E) also in Sylhet district, the aforementioned former student of mine collected two examples of an unidentified *Draco* which were subsequently deposited in the museum of the Zoology Department, Brahmanbaria Government College. However, these specimens are presently untraceable, and appear to have been either lost or destroyed.

This communication thus confirms the presence of *Draco blanfordii norvilii* from north-eastern Bangladesh. This fairly widespread lizard has also been recorded from the north-east Indian states of Assam and Nagaland and Myanmar, accordingly to Musters (1983).

I thank Mr. P. Dev., Head of the Department of Zoology, Sylhet University College for permitting me to borrow the specimen, Mr. Hasmatullah, who transported it, and Mr. Kader for providing unpublished information.

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RANGE EXTENSION IN SOME SOUTH INDIAN AMPHIBIANS

During the past century, over 100 species of anurans (frogs and toads) have been and described from south India. A majority of these (72 species) are endemic to the Western Ghats. For many species the known geographical ranges do not extend beyond the localities from which they were first collected and described. This is at least partly due to the fact that many parts of the Western Ghats have not been systematically surveyed. Many amphibians show diel activity pattern and are seasonal. Thus species may be easily overlooked.

Since April 1990 I have been studying the amphibians in the Western Ghats. During this period I have encountered at least 36 species of anurans and a few of these in localities where they were not previously recorded. Here I present the details of the range extension of these species. Specimens collected during the study have been deposited at the Bombay Natural History Society. One example of the treefrog *Polypedates cruciger* was deposited at the Zoological Survey of India, Madras. All frogs and toads were collected from within private estates in the Kanyakumari District (Tamil Nadu State) and Dakshina Kannada District (Karnataka State).

Family Bufonidae:

1) *Ansonia ornata*: I found this rare and brightly-coloured torrent toad to be locally common within a private estate on Charmadi Ghats of Dakshina Kannada. This small toad was originally known only from Kodagu in Karnataka (Inger and Dutta, 1986). I came across several adults, juveniles and tadpoles in October 1990 at elevations between 500-700 m in and along torrential streams and in litter within evergreen forests (Daniels, 1991).

2) *Bufo hololius*: A small toad known from Kerala and Andhra Pradesh (Inger and Dutta, 1986). An amateur naturalist Mr. S. Karthikeyan collected this toad from scrub covered hills near Bannerghatta National Park (Bangalore) in September 1991.

3) *Bufo parietalis*: This fairly large toad was only known from Kerala (Inger and Dutta, 1986). It is very common and breeds in the month of December at altitudes of 1,100 m in Silent Valley. I also came across one adult, possibly a male, foraging in the litter in the evergreen forests of Charmadi Ghats, Dakshina Kannada one night in October 1990 at an altitude of 500 m.

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Family Microhylidae:

4) *Uperodon systoma*: The balloon frog is apparently common in the plains. It is known from parts of Kerala and Karnataka (Inger and Dutta, 1986). I found an adult male in May 1990 under a partially burnt log in the moist deciduous forest in Mudumalai Wildlife Sanctuary, Tamil Nadu at an altitude of 1,000 m.

Family Ranidae:

5) *Micrixalus saxicolus*: This elegant stream frog was known only from Kerala (Inger and Dutta, 1986). However, I found this species to be common in the month of October and April in an estate at 500 m on the Charmadi Ghats, Dakshina Kannada. Males were found calling from rocks during the day in torrential streams. I also found males calling in April 1991 from hill streams in evergreen forests at an elevation of 1,360 m further north in Chickmagalur District, Karnataka.

6) *Nannobatrachus beddomi*: This tiny frog is known from Kerala (Inger and Dutta, 1986). I have collected this species beside estate roads and within betel-nut gardens between 400 - 700 m in Kanyakumari District, Tamil Nadu State in June 1990. The call is very diagnostic, and I have heard the species within evergreen forests above 1,000 m at Kalakad in Tamil Nadu during July 1991.

7) *Nyctibatrachus aliciae*: This small and little-known species of wrinkled frog was first described from the hills of Ponmudi (Kerala) by Inger *et al.* (1984). It is likely to occur in the evergreen forests of Charmadi Ghats in Karnataka. I came across several males calling from a wet area at 600 m during several nights in April 1991. The call was very bird-like and hence caught my attention. After I collected a few males and examined them they seemed to be closer to *N. aliciae* than any other species of *Nyctibatrachus* described hitherto.

8) *Nyctibatrachus humayuni*: This large species of wrinkled frog was first described from northern Karnataka and Maharashtra (Bhaduri and Kriplani, 1955). It also occurs in Dakshina Kannada where I heard many males at night in a stream within a cocoa plantation on the Charmadi Ghats in October 1990. These frogs were in cool water at an altitude of 500 m. Earlier during the day, I had collected a large female wrinkled frog from a stream flowing through evergreen forest close by. The size (snout-vent length) originally recorded for this species is not more than 5.0 mm. However, the male I collected measured 5.8 mm and a probable female, 80 mm.

9) *Nyctibatrachus major*: This small species of wrinkled frog has not been recorded outside Kerala since its first description in 1882 (Inger and Dutta, 1986). Its range is now extended to include Tamil Nadu and Karnataka. I first came across this species in streams in the hills of Kanyakumari district during June 1990. The frogs were active at night at 400 m. I have also recorded this species in Charmadi Ghats and Kalakad at elevations of 500 m and 1,000 m, respectively.

10) *Rana keralensis*: This medium-sized frog is known from Kerala (Inger and Dutta, 1986). I found it to be common and collected a few from the streams and forests of Kanyakumari District in Tamil Nadu. The frogs were common from below 50 m to nearly 700 m elevation. This species is also common in coastal Karnataka from nearly sea level to 300 m. The most northerly record of this species is of a single adult near a stream in a patch of forest on Roha Ghat, Maharashtra in October 1990 (Daniels, 1992). There is also one example of this species that was sent to me recently from the Shevaroys.

11) *Rana murthii*: This small frog that resembles *R. keralensis* was first described from Gudalur, Tamil Nadu (Pillai, 1979). A small *Rana* that I collected on a rainy night in October 1990 near my camp in an estate on Charmadi Ghats turned out to be *R. murthii*.

The single specimen was foraging at an elevation of 600 m. It resembles *R. keralensis* in general appearance and *Tomopterna breviceps* in being rather stubby. The shorter limbs and reduced webbing on the toes separate it from *R. keralensis*. More specimens were later sent to me for identification from a betel-nut plantation at Vittal (Dakshina Kannada).

Family Rhacophoridae:

12) *Philautus charius*: This small tree frog was earlier known from Kerala and Karnataka (Inger and Dutta, 1986). I found a calling male at an elevation of 1,000 m at Kalakad, Tamil Nadu in July, 1991. The frog was in leaf litter in an evergreen forest during the day.

13) *Polypedates cruciger*: This elegant tree frog was considered endemic to Sri Lanka (Morgan-Davies, 1958). I first came across large numbers of calling males within a clove plantation in June 1990 in the hills of Kanyakumari district at an elevation of 400 m. Later, I have seen the species in the forests of Charmadi Ghats and Baindur in Karnataka at 250 m; one I came across in October 1990 was moving towards a stream during the day. In November 1990, I found an adult rather dormant on a tree trunk with a group of *Philautus* adults during the day in an evergreen forest near Baindur.

I wish to acknowledge the Ministry of Forests and Environment, Government of India, for partial support of my field research. I thank R. S. Pillai and M. S. Ravichandran of ZSI (Madras), A. G. Sekar (BNHS) and Indraneil Das (MCBT) for their help in identifying some of the species. Finally, I wish to acknowledge the co-operation extended by the Neria and Glenbeck Estates during my study.

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Hamadryad, Vol. 17, pp. 42-45, 1992

EGGS AND HATCHLINGS OF SOME LIZARDS FROM BORNEO

Of the natural history of the 100 or so lizard species on the continental island of Borneo, little is on record and the recent work on the island's saurofauna has been mostly taxonomic (but see Inger and Greenberg, 1966; Ota *et al.*, 1989). One of the objectives of field work in-

The single specimen was foraging at an elevation of 600 m. It resembles *R. keralensis* in general appearance and *Tomopterna breviceps* in being rather stubby. The shorter limbs and reduced webbing on the toes separate it from *R. keralensis*. More specimens were later sent to me for identification from a betel-nut plantation at Vittal (Dakshina Kannada).

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itiated at the Batu Apoi Reserve Forest, Belalong, Temburong District and Tasek Lama and Serasa beach, both in the Brunei-Muara District, Brunei Darussalam, is to fill this gap in our knowledge. This short communication presents data on saurian eggs collected from sites in Brunei. ID/NBD refers to my field number for specimens from Negara Brunei Darussalam, and all materials referred to have been deposited in the reference collection of the Department of Biology, Universiti Brunei Darussalam, Bandar Seri Begawan, Brunei Darussalam. Eggs and hatchlings were measured to the nearest 0.1 mm with Mitutoyo dial vernier calipers; the adult female *Bronchocela cristatella* with a steel tape measure. All weights were taken to the nearest 0.01 gm with a Mettler™ AE 260 Electronic Balance.

FAMILY GEKKONIDAE

Horsfield's gliding gecko *Ptychozoon horsfieldii* (Gray, 1827):

Material: One eggshell and one hatchling (ID/NBD 321).

Two eggs were found in the leaf litter of a tree buttress, on the trail to the East Ridge of Belalong, on 9/v/1992. One of these, which was damaged during excavation and not retained, had a living embryo. The other, which was nearly spherical with a flat pedicel and relatively hard-shelled, measured 13.7 x 11.9 m and weighed 1.05 gm. The hatchling emerged on 4/vi/1992, and measured 60 mm (total body length) and 34 mm (snout-vent length), and weighed 0.83 gm.

The reproductive biology of the five species of gliding geckos of the genus *Ptychozoon*, which are distributed over south-east Asia and the islands in the Bay of Bengal, is largely unknown. Tiwari (1961) discovered eggs of *Ptychozoon kuhli* on Car Nicobar island, Bay of Bengal, India, and noted that eggs had a flat circular "base", presumably their attachment site to the substrate, the eggs being laid above the ground on the tree bark. Although the Belalong eggs were recovered from the leaf litter, the presence of a circular, flattened area on the intact eggs suggests it might have been stuck to the tree trunk or on branches, and may have been dislodged accidentally.

Dwarf gecko *Hemiphyllodactylus typus* Bleeker, 1860:

Material: Two eggshells and two hatchlings (ID/NBD 03).

Two eggs were collected on 12/i/1992 from the hollow insides of a dead branch, ~ 1.0 m from the ground, in Tasek Lama, Bandar Seri Begawan. The eggs were not measured or weighed, and hatched on 15/iii/1992. These hatchlings measured 28.0 and 28.0 mm (total body length) and 17.7 and 16.5 mm (snout-vent length), and weighed 0.07 gm each.

Kopstein (1929) found eggs of the species in Java in Indonesia, that measured 6.5 x 5 mm and later (Kopstein, 1932) reported on eggs that were 8 x 6 mm (presumably in mean dimensions).

Flat-tailed gecko *Cosymbotus platyurus* (Schneider, 1790):

Material: One embryo, a hatchling, four eggshells (ID/UBD 561).

A cache of at least 11 eggs were found within a hole on the trunk of a *Casuarina* tree, approximately 3 m from the sea at Serasa beach, on 21/xi/1992. The "nest" was 48 cm from the substrate, and measured 2.5 x 5 cm. Six eggs were removed. Egg 1 and 2 were broken, egg 1 yielded a near-term neonate, which was preserved. Egg 2 also appeared fertile, but no embryo was visible. Eggs 3-6 were removed for incubation in the laboratory. These measured 10.0-10.6 (mean 10.3) x 8.5-8.9 (mean 8.7) mm. Chou (1979) gave the egg dimensions for *C. platyurus* (as *Platyurus platyurus* from Singapore: 10.8-11.2 (mean 11.0) x 8.7-9.1 (mean 8.92) mm, close to the dimensions reported earlier for the Bornean samples.

On 5/xii/1992, egg 3 hatched. The hatchling measured 45.0 mm (total body length) and 23.3 mm (snout-vent length), and weighed 0.35 gm. The rest of the eggs failed to hatch due to unknown causes.

Tho and Ho (1979) reported a cache of 127 eggs of the giant forest gecko *Gekko stentor*, which they suspected were laid by a single female over a period of 23 months. The present cache of eggs, however, is suspected to be laid by several geckos, since *Cosymbotus platyurus* is a relatively small species, reaching a snout-vent length of 61 mm (De Rooij, 1915). Chou (1979) reported the utilization of the same nesting site by two gekkonid species, *C. platyurus* and *Hemidactylus frenatus*.

FAMILY AGAMIDAE

Six-lined flying lizard *Draco quinquefasciatus* Harwicke & Gray, 1827:

Material: Two dry egg shells and two hatchlings (ID/NBD 99).

A clutch of two eggs, each the shape of a peanut, was collected on 21/ii/1992 from the West Valley, Belalong. They were taken from about 2 cm below the surface, under leaf litter of a tree buttress. The eggs measured 17.2 x 9.6 and 16.8 x 10.2 mm and weighed 0.42 and 0.45 gm, respectively. Both eggs hatched on 29/ii/1992. The hatchlings measured 86.0 and 86.0 mm (total body length) and 30.3 and 30.4 mm (snout-vent length), respectively.

Inger and Greenberg (1966) reported one to four oviducal eggs in the species, and up to two in each oviduct, the size (presumably egg length) ranging from 10.5 to 19.0 mm.

Green crested lizard *Bronchocela cristatella* (Kuhl, 1829):

Material: One adult female, and two eggs (ID/NBD 373).

On 30/vi/1992, a gravid female *Bronchocela cristatella* was collected from the camp clearing in Belalong. The female measured 392.0 mm (total body length) and 92.0 mm (snout-vent length). Two fully-developed eggs were recovered, one from each oviduct, on dissection. The eggs measured 35.8 x 8.2 mm and 35.3 x 8.1 mm, and weighed 1.0 and 0.9 gm, respectively. Both were spindle-shaped with pointed apices, somewhat reminescent of the egg of *Bronchocela jubata*, rather than the oblong-shaped ones of *B. cristatella* illustrated in De Rooij (1915: 66; Fig. 42). This is in concordance with Smith's (1935) observations. Ota and Hikida (1991), however, obtained spindle-shaped eggs, like the Belalong material, and suggested that egg in the species may show geographic variation in shape.

The weight of the "spent" female was 13.0 gm. Relative clutch mass (ratio of clutch mass to body mass of spent female), egg mass index (ratio of mean egg weight to body mass x 100), egg length index (ratio of mean egg length to female snout-vent length x 100) were 0.15, 7.31 and 38.64, respectively. Both the eggs were infected with fungus after about a month under artificial incubation.

Support for this research was provided by Universiti Brunei Darussalam. I thank David Edwards, Webber Booth, Kamariah Abu Salim, Samhan bin Nyawa, David Jones and numerous colleagues at the Kuala Belalong Field Studies Centre for advice, assistance and aid during field work. Harry Andrews supplied references, as did the staff of the Sarawak Museum library.

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Hamadryad, Vol. 17, pp. 45-46, 1992

NOTES ON EGG SIZES AND TICKS OF THE YELLOW-LIPPED SEA KRAIT (*LATICAUDA COLUBRINUS*) ON PULAU PUNYIT, BRUNEI DARUSSALAM

Pulau Punyit (sometimes spelled 'Pulao Punyet') is one of two rocky islands off the north coast of Brunei Darussalam, on the southern edge of the South China Sea. This 0.1 ha. island is composed primarily of Tertiary limestone, and situated 500-600 m from the mainland at high tide. This brief communication present new information on the eggs and parasites of *Laticauda colubrinus* collected from these rocks during two trips made in May and October, 1992.

The amphibious sea snake or yellow-lipped sea krait, *Laticauda colubrinus* (Schneider, 1799) is a relatively terrestrial hydrophiid which produces eggs, unlike most other sea snakes that produce live young (Tweedie, 1983). Two adult females (snout-vent lengths 129.5 and 114.2 cm) were caught from the rocks on 16 May, 1992, between 1640 and 1650 hours. These were found in association with rocks and vines in the deep shade, and were presumably resting. Although several sloughed skins of the same species were recovered from the rocks during the same visit, no young of the species could be found. Both snakes collected proved gravid on dissection, containing nine and five relatively large oviducal eggs that measured 44.6-57.2 (mean 50.6) x 24.6-31.1 (mean 26.7) mm and 58.5-92.2 (mean 73.3) x 20.3-25.7 (mean 23.5) mm, respectively.

The parasite burden on these snakes is worthy of comment. Nine and 15 ticks of one or more indeterminate species were recovered from under the midbody and ventral scales. Since the species is highly terrestrial, resting, courting, mating and ovipositing on rocky islands (Pernetta, 1977; Stuebing, 1988), along with Pilong Rocks, Pulao Punyit may be the only terrestrial habitat for the species within Brunei.

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Two pairs of these snakes were found on 19 October, 1992 on a *Ficus* tree, four and seven m above the substrate, in the shade. The arboreal habits of *Laticauda colubrinus* from a locality in Sabah, eastern Borneo, have been documented by Stuebing *et al.* (1990). Two other solitary individuals, probably females, were encountered during the same visit. One of these was found sedentary on an exposed limestone boulder under partial shade at around 1200 hours, suggesting that it was basking.

My work on the herpetofauna of Brunei Darussalam was supported by Universiti Brunei Darussalam. Webber Booth made the trips to Pulao Punyit possible, and both Booth and David Jones provided excellent company during field work.

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Hamadryad, Vol. 17, pp. 46-48, 1992

CAPTIVE BREEDING OF ANURANS

Tropical frogs and toads are disappearing worldwide due to habitat damage or destruction (Blaustein and Wake, 1990). The tropical forests of India are also under human pressure, and many species of anurans are believed to be locally extinct or on the verge of extinction (Daniels, 1991a). The bronzed frog (*Rana temporalis*) which was common along hill streams in south India is today extinct locally in many parts. The Malabar torrent toad (*Ansonia ornata*) discovered a century ago in the Western Ghats of Karnataka exists as a highly localized species within about 50 km radius of the original site of discovery (Daniels, 1991b).

There are in all 102 species of anurans described from the Western Ghats of which several are either extremely rare or localized. The reasons for species of amphibians being localized or rare has been discussed in detail by Daniels (1992c). Significant damage to habitat in the past and present appears to be the most important factor responsible for the disappearance of species on the Western Ghats (Daniels, 1991c).

Captive breeding and reintroduction of anurans which are locally extinct, might help in sustaining populations. A dense canopy and a permanent supply of clean water are requisites for most species on the Western Ghats (Daniels, 1991c; Daniels, 1992c). For instance, a preliminary analysis of my data suggests that the evergreen forests are the richest in anurans, followed by the hill streams. I also found that the well-watered plantations of cocoa, cardamom and betelnut which are not fertilized with chemical fertilizers and well-watered human habitation in the hills can support as many or slightly lower number of anuran species as the natural habitats mentioned above. However, populations of certain forest species in these man-modified habitats are considerably lower. Availability of moist leaf litter is apparently one of the primary deter-

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minants of anuran diversity in the Western Ghats (Daniels, 1992a).

Captive breeding of anurans is being attempted for the first time in south India in a small outdoor cage at the Indian Institute of Science campus in Bangalore. The setup is small and simple (5m x 3m x 3m); the main frame of the cage being angled steel. The sides are covered with 5 mm wire mesh. This mesh size is ideal for letting in insects for feeding anurans of up to 75 mm snout-vent length. This is also effective in keeping out snakes which devour juvenile frogs and toads. The cage is roofed with thin asbestos on two ends to provide shade and with 5 mm mesh in the middle to let in rain water. The mesh on roof and one of the longer sides (the side that gets the sun most of the day) are closed with thinly-matted thatch to keep the inside cool.

The floor is rugged with large boulders on one side and two pools (1 m x 0.5 m x 0.1 m) on the other. The two pools are at the corners with a sloping channel (30 cm wide and 4 cm deep) connecting them. A tap with a continuous flow of water fills the first pool and drains the water into the next. A small vent covered with fine mesh takes the extra water out of the cage.

The pockets created between the boulders are filled with wet sand and shade-loving indoor plants are grown. Periodic sprinkling of water keeps the floor damp and cool. One flourescent lamp of 40 watts hung from the roof has provided enough light for observing anurans at night as well as attracting insects. Alates of ants and termites as well as small moths are the main food for the anurans. However, since the cage is situated outdoor, providing leaf litter on the floor soon attracted permanent colonies of terrestrial insects especially the smaller crickets and cockroaches which are taken by the frogs and toads. The light is kept on all night. In places where army ants can be a problem, a small moat with water may be constructed around the cage.

Temperature and relative humidity (RH%) measured through the year has shown that the inside weather conditions are approximately that of the surroundings. The maximum and minimum air temperatures recorded are 8° C and 36° C, respectively. Water temperature never went below 17° C and above 30° C. A maximum RH of 95% was observed during the rainy season and a minimum of < 10% during summer. The total cost of producing this cage was Rs. 6,000. Cost of electricity is extra.

Eight species of frogs and toads have survived in this cage for the past one year. The smallest adult measures 30 mm while the largest is 130 mm. A total of 20 individuals are together and only four are above 100 mm. Growth of juvenile frogs are being monitored. An endemic hill stream frog *Rana keralensis* readily bred in the pools and as many as 1,600 eggs were laid during a period of four months between January and April, 1991. Hatching ranged from 57% to 90%. Frogs metamorphosed 60 days after hatching into tadpoles. However due to predation by other species and cannibalism, only 120 survived (Daniels, 1992b).

The common toad *Bufo melanostictus* laid 2,000 eggs and about 100 of them emerged into young toads after 90 days. Two unexpected entries of water snakes (*Xenochrophis piscator* and *Atretium schistosum*) led to the destruction of many tadpoles within the cage.

Since anurans tend to be predators and cannibalistic on their juveniles, it is safer to keep only those species not more than 50 mm snout-vent length together in cages of this size. As most tropical frogs range between 25 to 40 mm, this cage should be ideal for breeding. If another similar cage can be maintained as a nursery for juvenile frogs, the number of frogs and toads entering the breeding population would be definitely higher than realized in this experimental cage at Bangalore.

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Hamadryad, Vol. 17, pp. 48, 1992

INDIAN MONITOR (*VARANUS BENGALENSIS*) FEEDING ON A BLACKBUCK (*ANTILOPE CERVICAPRA*) KILL

(with one plate)

On 3 July 1992, at 1300 hours, a pack of seven wolves (*Canis lupus*) killed a male blackbuck (*Antilope cervicapra*) in Pandit Jawaharlal Nehru Great Indian Bustard Sanctuary in Solapur District (17° 41' N; 75° 56' E), Maharashtra State, west-central India. The wolves ate one third of it and left the kill when disturbed by humans. Till late evening, I watched the kill from a distance to observe the wolves. An Indian monitor (*Varanus bengalensis*) came to the kill in the evening and fed on it for 15 minutes (Plate I). The lizard coiled its tail around one fore limb of the buck and bit three mouthfuls of flesh while the rest of the 15 minutes was spent eating, without support of its tail. It consumed about a quarter kilo of flesh. Next day, the same lizard came to the kill and ate about the same quantity of flesh in 10 minutes. Interestingly, the lizard came smelling the ground slowly and followed the same route used by the author to approach the kill. After feeding, the lizard did not return via the same route it took to the kill on both the days.

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Indian monitor (*Varanus bengalensis*) feeding on a blackbuck kill.

Photo: Satish Kumar

Mangrove catsnake (*Boiga dendrophila*). Photo: Indraneil Das

COMMENTARY

Hamadryad, Vol. 17, pp. 49-52, 1992

RECENT ADDITIONS AND TAXONOMIC REARRANGEMENT OF THE HERPETOFAUNA OF THE INDIAN SUBCONTINENT

This update lists a) new species and subspecies of amphibians and reptiles for the Indian Subcontinent that have been described recently (between 1991 to the time of this writing); b) recent (post-1987) relocation of species to new genera or genera different from the scheme in Smith (1935, 1943); and c) sinking of established genera and species. We feel this short review will be of use to colleagues in the region. Khan (1991) has listed new or newly-placed species of amphibians and reptiles from Pakistan, and this list complements his. A checklist and biogeographic analysis of the herpetofauna is under preparation.

As usual, colleagues helped out with literature: A. Bauer, W. Böhme, T. Hikida, J. B. Iverson, J. D. Lazell, A. Malhotra, W. Preiser, H.-J. Rummler, K.-D. Shulz, H. K. Voris, D.-T. Yang.

AMPHIBIA

ANURA

1. Yang (1991) described *Amolops nepalicus* from Sabhaya Kbota (= Khola), Nepal.

REPTILIA

TESTUDINES

2. Rummler and Fritz (1991) showed that *Cuora amboinensis* (Daudin, 1802) is composed of three subspecies, the one from Borneo and the Asian mainland, also occurring in north-eastern India and Bangladesh, being *Cuora amboinensis kamaroma* Rummler and Fritz, 1991. The two other subspecies are *C. amboinensis amboinensis* (Daudin, 1802) from the Philippines and the Indonesian islands of Maluku (the Moluccas) and Sulawesi (Celebes), and *C. amboinensis cuoro* (Schweigger, 1812), from Java and Sumatra, also in Indonesia.

3. Chkhikvadze (1988) described *Testudo horsfieldii kazachstanica* from Kazakhstan, this subspecies ranging into Turkmeniya. Subsequently, Chkhikvadze, Amiranashvili and Ataev (1990) described *Testudo horsfieldii nustomovi* from south-western Turkmenistan. The subspecies of the Central Asian tortoise in Pakistan is thus *Testudo horsfieldii horsfieldii* (Gray, 1844), this race also occurring in Iran, Afghanistan and China.

SAURIA

4. Szczerbak (1991) described *Alsophylax boehmei* from Ladakh, a politically disputed region claimed by India and Pakistan.

5. Das (1992) put *Cyrtodactylus madarensis* Sharma (1980) in the synonymy of *Eublepharis macularius* Blyth (1854).

6. Ota, Hikida and Matsui (1991) revived *Gekko verreauxi* (Tytler, 1864) from the synonymy of *Gekko smithii* Gray, 1842. *G. verreauxi* is restricted to the Andaman Islands.

7. Khan and Baig (1992) described yet another species of gecko of the genus *Tenuidactylus* from Gilgit, a politically disputed region claimed by India and Pakistan. The new species, *T. baturensis* is known from Pasu and Khaibar, both in Gilgit.

8. Khan (1992) revived *Gymnodactylus walli* Ingoldby (1922) from synonymy of *Gonydactylus stoliczkai* Steindachner (1867).

9. Baig (1989) described *Agama pakistanica* from Jaglotgah, Gilgit.

10. Greer (1991) established a new genus of scincid lizards from Sri Lanka, *Lankascincus*, and described three new species: *L. deraniyagalae*, *L. gansi* and *L. taylori*. Three skinks from this continental island, which were previously assigned to the genus *Sphenomorphus*, have been placed in the new genus. These are *L. deignani* (Taylor, 1950), *L. fallax* (Peters, 1860) and *L. taprobanense* (Kelaart, 1854).

11. Das (1991a) described *Mabuya gansi* from the Western Ghats forests of south-western India.

12. Bauer and Günther (1992) reviewed the reptile fauna of Himalayan kingdom of Bhutan and described a new species of skink from the vicinity of Samchi, *Mabuya quadratilobus*.

13. The genus *Cabrita* Gray (1838) has been synonymised under *Ophisops* Menetries (1832) by Arnold (1989), resulting in *C. jerdoni* Blyth, 1853 and *C. leschenaultii* (Milne-Edwards, 1829) being transferred to the genus *Ophisops*. Since *O. jerdoni* Blyth, 1853 is occupied, Arnold (*op. cit.*) established the name *Ophisops nictans* for *C. jerdoni*. However, Deraniyagala (1971) described a population of the species from Sri Lanka which he named *C. jerdoni minor*. The name *minor* Deraniyagala, 1971 was reinstated for the species by Böhme (1991), with the result *Cabrita jerdoni minor* from Sri Lanka becomes *Ophisops minor minor* Deraniyagala, 1971, while *Cabrita jerdoni jerdoni* from India becomes *Ophisops minor nictans* Arnold, 1989.

SERPENTES

14. Das (1991a) described a new sand boa from the coastal region of south-western India, *Eryx whitakeri*.

15. Lazell, Keirans and Samuelson (1991) put both *Ptyas* and *Zaocys* in the synonymy of *Coluber*, based on a study of hemipineal morphology. The following Indian colubrids have been transferred to the genus *Coluber* as a result: *Ptyas korros* Schlegel, 1837, *Ptyas mucosus* (Linnaeus, 1754) and *Zaocys ventromaculatus* Gray, 1834.

16. Schulz (1992) described a new subspecies of *Elaphe helena* from the Western Ghats, *Elaphe helena monticollaris*.

17. Wüster and Thorpe (1989) elevated the subspecies of *Naja naja* from the Indian Subcontinent to species rank: *Naja naja* (Linnaeus, 1758). *Naja oxiana* (Eichwald, 1831) and *Naja kaouthia* Lesson, 1831.

18. Gritis and Voris (1990) showed *Lapemis hardwickii* Gray, 1835 to be morphologically indistinguishable from, and hence a junior synonym of *Lapemis curtus* Shaw, 1802.

19. Auffenberg and Rehman (1991) revised the *Echis* complex from the Indian Subcontinent, and concluded that only one species, *E. carinatus*, is valid. Four subspecies were recognised: *E. carinatus carinatus*, (Schneider, 1801), *E. carinatus multisquamatus* Cherlin, 1981 *E. carinatus sochureki* Stemmler (1969) and *E. carinatus astolae* Mertens (1970).

20. Wüster *et al.* (1992) conducted a multivariate analysis of *Vipera russelli* and showed that the Sri Lankan population, *Vipera russelli pulchella* (Gray, 1842) is indistinguishable from *V. russelli russelli* (Shaw, 1797) of the mainland.

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Hamadryad, Vol. 17, pp. 52-53, 1992

INDIA'S HERPETOFAUNA: A PLEA FOR STANDARDISED DISTRIBUTIONAL RECORDS

India has a rich and interesting herpetofauna, but information is very patchy: although Murthy (1985) and Inger and Dutta (1987) provide more recent updates, workers often have to refer to such old publications as Smith (1931, 1935, 1943) for basic information on species. Accurate information on existence and distributions of species requires an expert knowledge of the animals, geography and the literature.

In the British Isles, the Biological Records Centre holds records of known presence of all reptile and amphibian species (besides birds, mammals, many other animals and plants) related directly to the standard maps of the region (Ordnance Survey) which prescribe a longitudinal/latitudinal based array of grid squares. For standardised distributional records, when a species is reliably recorded as present in a particular 10 km x 10 km square, this can be incorporated into the standing overall record.

Such a system has great benefits, from (1) allowing naturalists or potential researchers easy assessment of likelihood of species occurring in particular areas [standard field guides such as Frazer (1973) can and do incorporate such distribution maps rather than merely verbal descriptions] through (2) linking occurrence of species to available habitat types to (3) complex broad ecological data, on sympatry/parapatry/allopatry for example, and (4) detection of trends in range expansion or contraction. It can be seen that significance for conservation strategy could be extremely high.

Given such advantages, why is such a system not operating in other countries, India in particular? The objections seem to be practical, rather than fundamental objections to the principle: (1) Lack of pre-existing standard grid to which location can easily be related; (2) Patch records; and (3) Cost.

I believe a little co-operation between relevant government bodies, particularly perhaps the Geological Survey of India, could solve problem (1), provided the level of resolution is coarse enough to be acceptable for national security considerations. A grid based directly on longitide and latitude would seem eminently sensible: the Universal Transverse Mercator Projection, as used by various European mapping projects, would probably be most suitable (Vincent, 1990). Taking ease of construction, ease of use, problem (1), and problem (2) into account but retaining useful accuracy, an initial resolution of 20' of longitude/latitude (ca. 30 km) may be appropriate. B. C. Choudhury of the Wildlife Institute of India (*pers. comm.*) suggests the best solution, as currently used by the W. I. I. for a survey of freshwater turtles and land tortoise distribution, would be to relate all location records to the Survey of India 1:50,000 sheets. With regard to problem (3), an efficient solution to problem (1) could involve a minimum of bureaucratic effort, and maintenance of a central record (preferably computerised, since this makes adjustment and analysis so much simpler) should be an efficient use of

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resources (high benefit/cost ratio) with the benefits being so great; along with basic biological and ecological concepts, knowledge of which species exist where is a fundamental base for studies (and policy decisions) in general.

Of course these arguments also apply to other elements of India's fauna and flora. It may be that for birds and large mammals distributions are well enough known already for such a scheme not to be a crucial addition; conversely, invertebrates (except possibly butterflies) may be so little known that the patchiness of recorded distributions may seem to make such standard distribution maps not comprehensive enough to be of great use. However, even if such criticisms can be convincingly advanced I believe there are considerable benefits to be had for all taxa, and also for inter-taxa comparisons. Certainly for reptiles and amphibians, and it seems also for plants, such standardised distribution mapping, albeit inevitably incomplete, would be a major improvement in our knowledge.

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BOOK REVIEWS

STUDIES IN UROPELTID SNAKES by M. V. Rajendran.1985. Madurai Kamaraj University, Tamil Nadu, Madurai. v + 132 pp. Available from: Publications Division, Madurai Kamraj University, Madurai 625 021, India. Price: Indian Rupees 20.

For many years the uropeltids have been a family of snakes that have suffered greatly from neglect, undoubtedly due in part to the claim of many that these snakes are secretive and difficult to obtain, in comparison to the more obvious families of snakes. The bulk of my own library on the matter of uropeltids is two titles, Smith (1943) and Gans (1966), so it was with great interest that I picked up this book, sat down and entered its pages.

The book covers twenty species, those found in Tamil Nadu and Kerala, southern India and the text is, per the contents table, in two parts. The first is the usual Introduction, Materials and Methods. Also included here are notes on ecology, the tunnel systems of the animals, food and feeding habits and reproduction. The previous information on these latter sections has been sparse, but that presented in this book goes some way to correcting the balance. It proved interesting reading especially the problem of temperature, those collected and maintained by the author back at the laboratory soon succumbing to temperatures around 30° C. The second section of the book is looked at as two by myself: the species descriptions and, after the references, 20 pages of tables listing the scale counts for all the specimens collected by the author. The species descriptions are presented as full as possible, noting any taxonomic problems where they exist. Embryo counts for many species are also included.

Overall this little book goes some way to plugging a large gap in our knowledge on a fascinating snake family with just a few reservations on the final product. The book with an editor and a series of quality colour photos to illustrate the species would have been worthy of consideration by a publisher outside the subcontinent, thus making the title and its information more readily known and available. Maybe in the not too distant future after the undoubtedly to come taxonomic revision of Uropeltidae, the information could be represented with colour plates. Until then, this is an adequate title and should be on the book shelf of all those interested in these fascinating snakes.

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FROGS OF SABAH by Robert F. Inger and Robert B. Steubing. 1989. Sabah Parks Publication No. 10, Kota Kinabalu. 132 pp. Available from: Lun Hing Trading Company, A 928, 9th Floor, Wisma Merdeka, 88000, Kota Kinabalu, Sabah, East Malaysia. Malaysian Ringgit (M$) 16.50.

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Department, on a monograph to the freshwater fishes of north Borneo, as well as author several papers describing new species of fish. A majority of Inger's papers was published in *Fieldiana Zoology*, the organ of the Field Museum of Natural History, Chicago, U.S.A., where Inger still works. Others have appeared in *Amphibia-Reptilia, Copeia, Ecology, Ecological Monograph, Hamadryad, Journal of the Bombay Natural History Society*, to name a few, and deal with an unusual breadth of topics, from phylogenetic systematics to community ecology. Other scientists, impressed, inspired and influenced by Inger named several frogs and a snake after him.

This is Inger's first non-technical identification guide, but will set the standard for future fieldguides to the south-east Asian fauna. His coauthor in this work is Robert B. Stuebing, until recently with Universiti Kebangsaan Malaysia, Sabah, whose works include popular articles and technical papers on various Bornean vertebrates. Any attempt to popularise natural history in this part of the world is welcome particularly since deforestation for timber and urbanization at hyperspeed has wiped out much of the forests in Borneo, especially in the neighbouring state of Sarawak.

Paperback and printed on art paper, the binding of my copy has survived over six months of use in the Bornean jungle. The work has been organised into: Foreword, General biology of frogs, Frogs in folk lore and tradition, Classification of Sabah frogs (including a checklist of frogs and toads reported from Sabah), Ecology of Sabah frogs, and Key to frogs of Sabah. The book, as might be expected, deals with the more common species of the tailless amphibians of Sabah (i.e., excluding caecilians, those curious worm-like amphibians that few people see anyway), and of the 100 plus amphibian species recorded from this east Malaysian state, 56 are described and illustrated. Each account consists of a colour photograph (approximately 105 x 55 mm) of the beast in question, including the scientific name, (recommended) English name, a brief description (including shape, texture and colour, and sizes of adults of both sexes), habits and habitat (including descriptions and habitats of the larval stages, when known), calls and local names. Using the descriptions and the illustrations, it should be possible to identify at least the adults of the common frogs and toads found on Borneo.

The text is remarkably free of jargon and is especially suitable for students whose first language is not English. This is particularly important, since the life histories of so many of the common amphibian species are still unknown and warrant investigation. The photographs show frogs and toads with a wide range of shapes and colours, including the unusual, the spectacular and the bizarre (my personal favourite is the Bornean horned toad *Megophyrys nasuta*, a leaf-mimic that is incredibly hard to spot on the forest floor). The key is perhaps the other outstanding feature of this book, and relies almost entirely on colour and gross morphology, hence identification of a specimen in hand can be fairly straight-forward.The only criticism here is that several frogs and toads appear more than once in the key, including *Rana erythraea* (junctures 30A and 36A), *Ansonia spinulifer* (junctures 17A and 49A) and *Leptobracheila* species (junctures 53A and 55A).

Robert Inger is at present MacArthur Curator at the Division of Amphibians and Reptiles, Field Museum of Natural History, and is working on a second edition to his 1966 monograph, "The Amphibia of Borneo" published in the *Fieldiana Zoology* series, and reprinted in 1990*.

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Present address: Centre for Herpetology, Madras Crocodile Bank, Post Bag 4, Mamallapuram 603 104, Tamil Nadu, India.

*Both publications are available from Lun Hing Trading Company, Kota Kinabalu, address above.

CURRENT LITERATURE IN ASIAN HERPETOLOGY

Compiled by Harry V. Andrews and Farida Tampal

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FRAZIER, J. The land tortoise in Nepal: a review. 89 (1): 45-54.

KALAIRASAN, V., R. KANAKASABAI & B. RATHINASABAPATHY. Record of the riverine turtle *Trionyx leithi* from Thanjavur district, Tamil Nadu. 89 (2): 258-259.

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KHAN, A. R. Breeding habits of John's earth boa *Eryx johni*. 88 (2): 292.

KUMAR, R. Snakebite: an experience. 88 (3): 460.

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ANANJEVA, N. B. & B. S. TUNIYEV. Historical biogeography of the *Phrynocephalus* species of the USSR. 76-98.

BAUER, A. M. & R. GÜNTHER. A preliminary report on the reptilian fauna of the Kingdom of Bhutan with the description of a new species of scincid lizard (Reptilia: Scincidae). 23-36.

CHEN, Y., D. ZHANG, K. JIANG & Z. WANG. Evaluation of snake venoms among *Agkistrodon* species in China. 58-61.

CHEN, B. & B. LIANG. Preliminary research on the function of the eggshell in the Chinese alligator (*Alligator sinensis*). 137-140.

CONANT, R. The type locality of *Agkistrodon halys caraganus*. 57.

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GU, H., R. RUAN & Z. ZHANG. Electrocardiogram research on the Chinese alligator (*Alligator sinensis*). 137-140.

HERRMANN, H. J. & K. KABISCH. Investigations on ranid larvae in the Southern Sakhalin Island, Russia. 68-75.

HUANG, M., Y. CAO, F. ZHU & Y. QU. Female reproductive cycle and embryonic development of the Chinese Mamushi (*Agkistrodon blomhoffi brevicaudus*). 62-67.

ORLOV, N. L. & B. S. TUNIYEV. A new species of grass snake, *Natrix megalocephala*, from the Caucasus (Ophidia: Colubridae). 42-54.

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WEN, Y. A new species of the genus *Tropidophorus* (Reptilia: Lacertilia) from Guangxi Zhuang Autonomous Region, China. 18-22.

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26 (2) 1992

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WÜSTER, W. & M. J. COX. Defensive hemipenis display in the kukri snake *Oligodon cyclurus*. 238-241.

26 (3) 1992

CHOO, B. L. & L. M. CHOU. Does incubation temperature influence the embryos in *Trionyx sinensis*? 341-342.

KANAMADI, R. D. & C. S. JIRANKALI. Testicular activity in *Polypedatus maculatus* (Rhacophoridae): seasonal changes in spermatogenesis and fat bodies. 329-335.

MATSUI, M., H. IWASAWA, H. TAKAHASHI, T. HAYASHI & M. KUMAKURA. Invalid specific status of *Hynobius sadonensis* Sato: Electrophoresis evidence (Amphibia: Caudata). 308-315.

OHLER, A. & A. DUBOIS. The holotype of *Megalophrys weigoldi* Vogt, 1924 (Amphibia: Anura: Pelobatidae). 245-249.

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RASMUSSEN, A. R. Rediscovery and redescription of *Hydrophis bituberculatus*, Peters, 1872 (Serpentes: Hydrophiidae). 85-97.

WITHERINGTON, B. E. Behavioural responses of nesting sea turtle to artificial lighting. 31-39.

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48 (2) 1992

HAYASHI, T., M. MATSUI, T. UTSUNONMIYA, S. TANAKA & H. OTA. Allozyme variation in the newt *Tylototriton andersoni* from Three Islands of the Ryuku Archipelago. 178-184.

PACKARD, G. C., K. MILLER & M. J. PACKARD. A protocol for measuring water potential in subterranean nests of reptiles. 202-209.

48 (3) 1992

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GREER, A. E. The orientation of the embryo on the yolk mass in the squamates. 343-346.

HASUMI, M. & H. IWASAWA. Wandering behaviour and cutaneous changes in winter-dormant male salamander (*Hynobius nigrescens*). 279-289.

48 (4) 1992

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MURTHY, T. S. N. Some suggestions for further studies in Indian reptiles. 10-11.

SEKAR, A. G. Key to the amphibian fauna of Goa. 14-15.

SINGH, D. F. & R. M. SHARMA. A note on the status of the saw-scaled viper (*Echis carinatus*) in Sindhudurg district of Maharashtra. 11-12.

JAPANESE JOURNAL OF HERPETOLOGY

14 (3) 1992

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MORI, A., M. TODA, S. KADOWAKI & H. MORIGUCHI. Lying in ambush for nocturnal frogs: Field observations of the feeding behavior of three colubrid snakes, *Elaphe quadrivirgata*, *E. climacophora* and *Rhabdophis tigrinus*. 107-115.

NAKACHI, A. Effects of food deprivation on the subsequent growth of the hatchling *Elaphe taeniura friesei* in captivity. 124-128.

YASUKAWA, Y., H. OTA & T. HIKIDA. Re-evaluation of the two subspecies of *Geoemyda spengleri spengleri* (Gmelin, 1789) (Reptilia: Emydidae). 143-159.

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KAMEZAKI, N. & K. HIRATE. Size composition and migratory cases of hawksbill turtles, *Eretmochelys imbricata*, inhabiting the waters of the Yaeyama Islands. Ryukyu Archipelago. 166-169.

NISHIMURA, M. & T. KAMURA. Creamy white material ejected by male habu *Trimeresurus flavoviridis* (Viperidae). 163 - 165.

MORI, A. & T. HIKIDA. A preliminary study of sexual dimorphism in wing morphology of five species of the flying lizards, genus *Draco*. 178-183.

NOMURA, T. & H. IWASAWA. Gonadal development and germ cell kinetics in the course of sex differentiation in the salamander *Onychodactylus japonicus*. 170-177.

SATO, T. Reproductive behavior in the Japanese salamander *Hynobius retardatus*. 184-190.

YABE, T. Sexual difference in annual activity and home ranges of the Japanese pond turtle, *Mauremys japonica*, assessed by mark-recapture and radio-tracking methods. 191-197.

THE SNAKE

22 (2) 1990

AMBU, S., M. KRISHNASWAMY & J. JEFFERY. A study on endoparasites of some snakes in peninsula Malaysia. 120-125.

DESILVA, A. First record of a cobra (*Naja naja*) with a monocellate marking from Sri Lanka. 134-135.

_____. "Rostral appendage" of *Hypnale hypnale* from Sri Lanka. 136-137.

HIGA, H, H. VEGATO & Y. ARAKI. A case of snake bite in Okinawa, Japan. 100-105.

MUTHUSWAMY, E. & P. GOPALKRISHNAKONE. Python bites- case report. 113-119.

NAKAMOTO, E. A Himehabu (*Trimeresurus okinavensis*) swallowing a Habu (*T. flavoviridis*). 138-139.

PAN, W.-M, J.-F ZHANG & W.-X. HAO. Thrombolytic effects of snake venom antithrombotic enzyme on coronary thrombosis in dogs. 106-112.

RASMUSSEN A. R. & M. ANDERSEN. The sea snake *Kerilia jerdoni* Gray (1849). First record from Andaman Sea, Phuket Island, Thailand, with remarks on the two subspecies. 131-133.

SAWAI, Y. Y. KAWAMURA & Y. KUROKOUCHI. Study on the environment related with Habu (*Trimeresurus flavoviridis*) bite on the Amami Island of Japan. 87-92.

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stance) on the venom of *Rhabdophis t. tigrinus* (Japanese Yamakagashi). 93-99.

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AMBU, S. & C. S. NG. The first record of green cat snake (*Boiga cyanea*) from peninsular Malaysia. 40-41.

GOPALKRISHNAKONE, P. Structure of the sublingual salivary gland of the reticulated python, *Python reticulatus*. 19-24.

HAO, W.-X. & J.-H. QU. Effectiveness of Arginine lipidase (Svate) separated from Chinese Mamushi (*Agkistrodon blomhoffii brevicaudus*) venom applied for the treatment of 3323 cases of cerebral thrombosis. 10-13.

KUCH, U. Abnormal colouration in the banded krait, *Bungarus fasciatus* (Schneider, 1801). 25-28.

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